JPRS 77486

2 March 1981

··· FBIS·40TH YEAR·1941-81 ···

USSR Report

MATERIALS SCIENCE AND METALLURGY

No. 72

FBIS FOREIGN BROADCAST INFORMATION SERVICE

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

PROCUREMENT OF PUBLICATIONS

JPRS publications may be ordered from the National Technical Information Service (NTIS), Springfield, Virginia 22161. In ordering, it is recommended that the JPRS number, title, date and author, if applicable, of publication be cited.

Current JPRS publications are announced in Government Reports Announcements issued semimonthly by the NTIS, and are listed in the Monthly Catalog of U.S. Government Publications issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Indexes to this report (by keyword, author, personal names, title and series) are available through Bell & Howell, Old Mansfield Road, Wooster, Ohio, 44691.

Correspondence pertaining to matters other than procurement may be addressed to Joint Publications Research Service, 1000 North Glebe Road, Arlington, Virginia 22201.

FOREIGN BROADCAST INFORMATION SERVICE
P. O. Box 2604
Washington, D. C. 20013

26 February 1981

NOTE FROM THE DIRECTOR, FBIS:

Forty years ago, the U.S. Government inaugurated a new service to monitor foreign public broadcasts. A few years later a similar group was established to exploit the foreign press. From the merger of these organizations evolved the present-day FBIS. Our constant goal throughout has been to provide our readers with rapid, accurate, and comprehensive reporting from the public media worldwide.

On behalf of all of us in FBIS I wish to express appreciation to our readers who have guided our efforts throughout the years.

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. JPRS 77486	2.	3. Recipient's Accession No.

4. Title and Subtitle	5. Report Date
USSR REPORT: MATERIALS SCIENCE AND METALLURGY, No. 72	2 March 1981
	6.
7. Author(s)	8. Performing Organization Rept. No.
9. Performing Organization Name and Address Joint Publications Research Service 1000 North Glebe Road Arlington, Virginia 22201	10. Project/Task/Work Unit No.
	11. Contract(C) or Grant(G) No (C) (G)
12. Sponsoring Organization Name and Address As above	13. Type of Report & Period Covered
	14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

The report contains articles, abstracts and news items on metals, alloys and superalloys, analysis and testing of metals and materials, coatings, composites, metal corrosion, extraction and refining, forming, instrumentation, lubricants, mechanical and physical properties of metals, powder metallurgy, textiles, welding practice, glass and ceramics, heat treatment, nuclear science and technology, semiconductor technology, thermomechanical treatment, and related fields.

17. Document Analysis a. Descriptors

USSR
Metallurgy
Welding
Corrosion
Crystallography
Solid State Physics
Lubricants

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group 11B, 11F, 11H, 13H, 20B, 20L

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Unlimited Availability Sold by NTIS Springfield, Virginia 22161	UNCLASSIFIED	61
	20. Security Class (This Page) UNCLASSIFIED	22. Price

(See ANSI-Z39.18)

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

JPRS 77486

2 March 1981

USSR REPORT

MATERIALS SCIENCE AND METALLURGY

No. 72

CONTENTS

ALUMINUM AND ITS ALLOYS

On the Development of Pressure Working of Aluminum Alloy Granules... 1

COMPOSITE MATERIALS

Realization of the Strength of Boron Fibers in a Composite With a Metallopolymer Matrix.. 2

Reduced Failure Ductility of Composite Materials.................... 2

Influence of Structure on the Properties of Carbon Fiber Materials.. 3

Dynamics of Redistribution of Stresses When Fibers Are Broken in a Composite.. 4

FERROUS METALLURGY

The Effectiveness of Structural Displacements in the Production and Consumption of Ferrous Metals................................ 5

GLASS AND CERAMICS

On the Question of the Influence of Working Media on the Strength of Industrial Glass and Sitall................................ 19

MECHANICAL PROPERTIES

Mechanical Properties of Electron-Beam Welded Joints Between Strips or Plates of 1201 Aluminum Alloy.......................... 20

NONFERROUS METALLURGY

New Method in Nonferrous Metallurgy Described 21

 [III - USSR - 21G S&T]

Nonferrous Metallurgy of Tajikistan: Concerns, Problems, Prospects... 25

POWDER METALLURGY

A New Method of Producing Single-Crystal Aluminum Powder With a Highly Developed Particle Surface.................................... 31

Investigation of the Growth of Wear-Resistant Titanium Carbide Layers on Hard Alloys.. 32

High-Porosity Permeable Materials Made of Metal Fibers. I. Investigation of Strain Effects and the Quality of Mechanical Contacts in Fibrous Materials During Sintering........... 33

Improving Ductility of Aluminum and Copper Alloys by a Granulation Method.. 33

Interaction of Titanium Nitride in Composites With Ni and Ni-Mo....... 34

Investigation of Thermal Processes During Hot Hydrostatic Pressing of Heat-Resistant Nickel Alloy Powders..................... 35

Wear-Resistant Bronze-Base Composite Produced by Electric-Discharge Sintering... 35

Investigation of the Physico-Mechanical Properties of Titanium Carbide With Additions of Titanium Nitride.......................... 36

Interaction of Boron Carbide With Titanium Under Conditions of Thermal and Plasma Heating.. 36

Electrical-Discharge Sintering of an Aluminum-Carbon Fiber Composite.. 37

Features of the Process of Sintering Nickel Fibers Extruded From Viscose-Base Suspensions.. 38

On the Production of Multicomponent Metallic Powders With a Prescribed Composition, Structure and Properties.................... 39

STEELS

Nitriding of Steel Under Vacuum 40

TITANIUM

Influence of Thermal Straightening on the Fatigue Strength of a Titanium Alloy 41

Lubricant for Hot Pressure Shaping of Titanium Alloys................. 42

Effect of Plastic Surface Deformation on the Surface Quality and the Fatigue Strength of an α-Phase Titanium Alloy.................. 43

Interaction of Atmospheric Moisture With Titanium Sponge............. 44

Effect of Hydrogen on the Notch and Crack Sensitivity of OT4 Titanium Alloy 44

Dependence of the Cycle Life of VT6 Titanium Alloy on the Surface Roughness and Effectiveness of Hardening This Alloy by Plastic Surface Deformation 45

WELDING

Comparison of Laser and Arc Welding Processes......................... 46

Investigation of the Spectrum of the Arc Plasma in Argon Arc Welding of Titanium With a Tungsten Electrode in Relation to the Flux...... 46

Dynamics of Channel Formation Under Conditions of Electron Beam Welding 47

Strength and Quality Control of Weld Joints Made From Aluminum-Boron Composites... 48

Relaxation of Stresses During Heat Treatment of Titanium Alloy Weld Joints.. 49

Diffusion Welding of Finned Panels Made of Titanium Alloys 50

MISCELLANEOUS

Metal: Ways To Economize 51

A Low-Energy High-Density Pulsed Electron Beam for Surface Heating... 55

Protection of Carbon Materials by High-Melting Compounds............. 55

Anodic Behavior of Molybdenum-Rhenium Alloys......................... 56

Structure of Phase Anodic Aluminum Oxide Formed in Sulfamic Acid Solutions.. 56

Effect of Temperature on the Physical and Mechanical Properties of Carbonplastics... 57

Analysis of Strain Hardening of Titanium Nickelide.................. 57

Mechanical Properties of IMV-2 Alloy After Superplastic Deformation.. 58

ALUMINUM AND ITS ALLOYS

UDC 669.715:621.777:492.3

ON THE DEVELOPMENT OF PRESSURE WORKING OF ALUMINUM ALLOY GRANULES

Moscow TSVETNYYE METALLY in Russian No 9, Sep 80 pp 88-90

SHEPEL'SKIY, N.V.

[Abstract] A description is given of research done on compacting of aluminum granules into intermediate workpieces. An analysis is made of factors that influence the strength of bonding between granules: the physicochemical properties of the metal, presence of oxide films and impurities, structural defects, the capability for forming metallic bonds and the technological conditions of compacting the granules (pressure and temperature). Effects that are detrimental to the quality of the finished piece include crack formation due to nonuniform deformation, and also the release of hydrogen in supersaturated solution in the granules. A gradient of strain rates of adjacent volumes of the metal can be observed with pressure working of the granules. This difference in strain rates results in tensile and shear stresses that are localized in separate places within the body of the workpiece, and produces microcracks oriented in the directions of preferred flow of the metal. Among problems that require attention in production of high-quality granulated materials are: controllability and reproducibility of the casting process to ensure predetermined properties; selection of temperature-time parameters to maximize outgassing; minimizing temperature and pressure in briquetting; finding ways to intensify renewal of contact surfaces of the granules during pressure working; optimizing conditions of drawing parts from granules; optimizing heat treatment schedules. References 7: all Russian.
[7-6610]

UDC 621.762:678:620.17

REALIZATION OF THE STRENGTH OF BORON FIBERS IN A COMPOSITE WITH A METALLOPOLYMER MATRIX

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 80 pp 64-67 manuscript received 20 Oct 79

KARPINOS, D.M., KADYROV, V.Kh. and ASKOCHENSKIY, Yu.B., Institute of Problems of Material Science, UkSSR Academy of Sciences

[Abstract] Boron fibers 140 microns in diameter were used for reinforcement in a matrix made of an epoxyphtalate resin and a sprayed duralumin alloy. The strength of this material in static tension tests, its density and elastic properties were equal to those of high-molecular plastics but the shear modulus in the sheet plane and interlayer shear were an order of magnitude higher due to the presence of metal in the matrix. After testing samples of different lengths it was determined that the longer a sample, the lower its strength due to an increase in the probability of a weak link. Thus there is an "effective" length that a pack of fibers has which realizes the overall strength of the composite. Figures 2; references 4: 3 Russian, 1 Western.
[190-6368]

UDC 531:539.4.01

REDUCED FAILURE DUCTILITY OF COMPOSITE MATERIALS

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 80 pp 21-24 manuscript received 1 Mar 78

ALYUSHIN, Yu.A., ALYUSHINA, N.I., KON'KOV, Yu.D. and VOLODIN, V.L., Rostov-on-the-Don Higher Technical School, Rostsel'mash

[Abstract] On the basis of Griffith's energy, criterion relationships were produced for determining the failure ductility of layer materials with an arbitrary ratio of layer thicknesses using the modulus of elasticity, Poisson ratios and failure ductility of those pure metals contained in the composition. It was shown that the known rule of mixtures, applying a linear relationship of failure ductilities of the composition and constituent metals, is a result of the force criterion of failure. A comparison of experimental data is presented with calculated values of K_{1c}

for different bimetals produced by hard surfacing. For experimentation, steels 38KhN3MFA and 40KhNMA were surfaced, the first steel with Sv07Kh25N12G2T and Sv09Kh19N?F2S2 rod and the second steel only with the second rod with both done under 48-OF-11 flux. Tests showed good correspondence between the calculated and experimental values of failure ductility (less than 3 percent) with the experimental values being higher. The 40KhNMA steel with the largest difference between layer thicknesses had the highest values of failure ductility, being 266 kG/mm $^{3/2}$ for a thickness ratio of 20/5mm. References 10: 7 Russian, 3 Western.
[2-6368]

UDC 539.4:678.067.4:539.2

INFLUENCE OF STRUCTURE ON THE PROPERTIES OF CARBON FIBER MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 4, Jul-Aug 80 pp 616-620 manuscript received 25 Jun 79

KOSTIKOV, V.I., KOLESNIKOV, S.A., KHOLODILOVA, Ye.I., VAVILKINA, S.V., POLILOV, A.N., KHOKHLOV, V.K., BUTYRIN, G.M., NABATNIKOV, A.P., SHEPILOV, I.P. and SHURSHAKOV, A.N.

[Report presented to the Fourth All-Union Conference on the Structure, Properties and Applications of Composites, Moscow, Nov 1978]

[Abstract] Quantitative relations were found for the way that the parameters of the porous structure of a carbon-carbon material with fiber filler depend on the configuration of the carbon matrix and the conditions of the technological process of making the composite. Four groups of pores were distinguished: 1) The pores in the fiber filaments; 2) Those associated with the textile elements of the filler; 3) Those associated with the configuration of the matrix; 4) The pores of the binder in the space between filaments. Due to the large number of factors that influence the porous structure of such materials, planned experiments were done with 16 modifications of carbon-carbon materials. Analysis of the results yielded linear regression equations for the dependence of the percent concentration of pores in the material on the parameters of the technological process of manufacture. It was shown that the carbon material contributes appreciably to the interlayer strength. A strength criterion was proposed for laminar composites that explains the dependence of interlayer strength on the span-to-height ratio of a beam. Figures 3; references 14: 7 Russian, 7 Western.
[6-6610]

UDC 539.4:678/067.4

DYNAMICS OF REDISTRIBUTION OF STRESSES WHEN FIBERS ARE BROKEN IN A COMPOSITE

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 4, Jul-Aug 80 pp 608-615 manuscript received 29 Jan 80

SAKHAROVA, Ye.N. and OVCHINSKIY, A.S., Institute of Metallurgy imeni A.A. Baykov, USSR Academy of Sciences, Moscow

[Abstract] An analysis was made of dynamic effects that accompany the redistribution of stresses in fibers adjacent to a broken fiber in a composite. It was assumed that one fiber breaks under the action of a tensile load applied along the fibers. Motion of the end sections of the broken fiber was impeded by the tangential forces that arise in the matrix. These forces redistribute the load via the matrix to adjacent fibers, which are thus put into motion. On the basis of this one-dimensional model it was shown that the process of motion of the broken fiber and three zones of adjacent fibers for various stages of shear strain of the material and separation of the broken fiber from the matrix can be described by systems of differential equations of hyperbolic type. These equations were numerically solved on a computer by the method of characteristics. Analysis of the redistribution of stresses in fibers adjacent to the broken one revealed overload waves that form in the planes of discontinuity and that may break fibers at a considerable distance from the plane of discontinuity. The overloads on adjacent fibers are reduced as the broken fiber separates from the matrix. Figures 8: references 9: all Russian.
[6-6610]

THE EFFECTIVENESS OF STRUCTURAL DISPLACEMENTS IN THE PRODUCTION AND CONSUMPTION OF FERROUS METALS

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA EKONOMICHESKAYA in Russian No 4, Jul-Aug 80 pp 132-145

[Article by N. P. Ivantsova]

[Text] Changes in the structure of metal consumption and metal production over a long period in the national economy and sectors thereof are examined. The intensity of structural shifts in metal production by five-year plans is analyzed. The basic trends in technological progress, facilitating improvement of the quality and formation of an efficient structure of metal, are investigated. The technical-economic conditions for improving the technical level of the production of economic kinds of metal are presented.

The volume of the metal stockpile of our country is an important indicator of its economic potential and national wealth. The USSR took first place in the production of ferrous metals: in 1978 151.5 million tons of steel and 105.4 million tons of finished rolled stock were manufactured. However, even that high level does not completely meet the needs of sectors of the national economy. The rapid development of science, technology and production requires substantial improvement of the properties of construction materials and the development of new, lighter and stronger kinds than before. The deficient production of metal of the appropriate quality and variety is delaying the development of technical progress and improvement of the effectiveness of social production. At the same time modern production is characterized by comparatively high metal expenditure and excessive waste of metal. The metal consumption of machine-building and metallurgy in the USSR is 20-25% higher than in the United States. Of all the steel melted in the USSR only a little more than half goes to society in the form of automobiles, metal wares and appliances, and waste accounts for the rest of it. Alteration of metal consumption in production and reduction of production waste are influenced by technical factors and by the industrial and intraindustrial structure of the demands for metal. Most important are the technical factors: the structure of metal production and rolled stock, processing technology and the economy of constructions and the adoption of substitutes for metals. Chief among them is the efficient structure and corresponding quality of metals.

Structural Shifts in Metal Consumption in 1950-1977

About 80% of the total consumption of ferrous metals in the national economy is made up of finished rolled stock, pipe, products for future processing and metal wares; steel and iron castings and forgings account for a little more than 20%. The proportion of steel pipes, semifinished products and metal wares in the structure of metal consumption has been increasing in recent years, and the proportion of cast products has decreased (Table 1). This is related to the fact that semifinished products and metal wares are higher-quality kinds of rolled stock. Their application reduces the cost of metal processing and improves the performance characteristics of the manufactured machinery and constructions.

Table 1. Structure of Consumption of Ferrous Metals in Soviet National Economy, %*

	Year						
	1950	1955	1960	1965	1970	1975	1977
Finished rolled stock	60.2	54.6	58.4	53.8	52.8	52.7	52.5
Steel pipe	8.0	8.9	9.2	12.1	13.2	13.3	13.5
Semifinished products and metal wares	7.2	9.1	8.5	10.0	11.5	12.4	12.6
Forgings from castings	1.1	1.1	1.1	1.2	1.1	1.1	1.1
Steel and iron castings	23.5	26.3	22.8	22.9	21.4	20.5	20.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

*Calculated by author

The mentioned changes are indicative of progressive trends in social production. The relatively high proportion of castings in the structure of the consumption of metals is attributed to some shortage of certain kinds of ferrous rolled stock, which is compensated for by the manufacture of castings and forgings from ingots, especially heavy ones. The extensive application of progressive technology, capable of producing thin-wall castings, and light precision castings with substantially more rigid tolerances and with thinner walls, the replacement of castings with stampings and with welded sheet metal parts and the corresponding shifts in the structure of machine-building can play an important role in a reduction of the proportion of castings.

An analysis showed that it is possible in the future to reduce the volumes of production and consumption of castings by 5-7 million tons annually by replacing cast parts with rolled products and by reducing its utilization in ingot molds. The use of ingot molds and bottom plates, made of iron castings, will decrease with the development of continuous steel melting. The replacement of cast iron with stampings and welded semifinished products for the production of household appliances, heating radiators, bathtubs, beds of presses and milling machines, gear boxes, roller tables, conveyors, etc., is extremely effective.

More than 60% of the ferrous metals consumed by the Soviet national economy goes to machine-building and metal milling. The level of industrial metal consumption and of the gross national product will depend on how metal is used in that sector. The structure of metal consumption in nine sectors of machine-building in 1966-1977 is characterized by the following ratios (in %):

	1966	1977
Iron castings	21.6	20.2
Steel castings	9.5	8.4
Ferrous rolled stock	59.5	56.3
Semifinished products	2.2	6.3
Metal wares	2.7	3.0
Pipe	4.5	6.0

The consumption of castings remains comparatively high. However, they are considerably more costly to the public (especially steel) than rolled stock. It is desirable to accelerate rolled stock production rates and to allocate the necessary volumes for replacing castings.

Finished rolled stock accounts for more than 50% of the total consumption of ferrous metals. Sheet products are more economical in the rolled stock inventory. The proportion of sheet steel increased (for example, by 5.8 points in machine-building in 1966-1977) in the structure of rolled products consumed by the Soviet national economy and basic consumer sectors. This increase reflects progressive trends in the structure of the consumption and production of metal products and in the change of the intraindustrial structure of metal consumers. Improvements continue to be made in the constructions of machinery, methods of production and processing of metals, and many new sectors and spheres of application of sheet products have appeared.

However, the proportion of merchant steel in the consumption of rolled stock remains high even today in connection with the deficient production of rolled sheet metal and slow rates of improvement of the merchant metal itself. There continues to be a shortage of merchant rolled stock in economical profile sizes, especially lightweight ones. The proportion of merchant steel in most sectors is on the 40% level, and in construction it is 53%. Meanwhile, the utilization coefficient of merchant rolled stock is known to be lower than that of sheet metal.

Expansion of the variety of rolled stock in proportion to sheet, especially thin sheet and cold rolled thin sheet steel, is one of the important economic indices of the structure of rolled stock. It predetermines the efficient utilization of metal in the national economy and promotes a reduction of metal waste and reduction of metal consumption in production. Even today, however, the proportion of thin sheet steel, including cold rolled, in consumption is still inadequate, and the proportion of sheet steel is high -- about 34%. Meanwhile the high rates of expansion of electrical engineering machine-building and instrument engineering, expansion of the production of consumer goods, development of the automobile industry and chemical machine-building require the production of sheet metal products at advancing rates.

The ratio of sheet steel used in electrical engineering and chemical machine-building for the production of household appliances, consumer goods and packaging is very high, and in highway construction machine-building it is 50-70%, i.e., 1.3-1.7 times higher on the average than in machine-building. There are several reasons for the relatively high proportion of sheet in these machine-building subsectors: features of constructions, their progressiveness, streamlining of the structure of rolled stock and progress in metal processing, i.e., conversion to the production of stamped and welded parts from sheet metal instead of castings

or forgings and mechanically processed merchant rolled stock. These subsectors are characterized by the manufacture of products that require a large volume of sheet metal.

The structure of rolled stock is relatively progressive in electrical engineering and road-building machine-building and in machine-building for the food industry. Less sheet metal is consumed in textile machine-building, in the manufacture of home appliances and in certain chemical and petrochemical machine-building subsectors. The proportion of thin sheet, including cold rolled, is still too small in nearly all machine-building sectors and subsectors.

The high proportion of castings and merchant steel in the structure of metal consumption is attributed to considerable waste, basically in the form of shavings, and excessive metal consumption in production. About 9 million tons of cast iron and steel shavings were made in the USSR in 1977. According to calculations done by experts, the amount of rolled stock can be cut approximately in half by improving its structure.

To determine the dynamicity of structural shifts, including for individual kinds of metal products, we calculated the growth rate intensity coefficient. For this purpose we used the formula for the mean square deviation of the growth rates of individual kinds of metal from the growth rates of the results according to the structures which we analyzed. The higher the coefficient the more intense are structural shifts. The intensity coefficient of structural shifts can be used for comparing the abruptness of structural shifts by five-year plans, i.e., it tells when they occurred faster. We determined the intensity of structural shifts in metal production, rolled stock and sheet metal for the years 1950-1975 by five-year plans (Table 2).

Table 2. Coefficients of Intensity of Structural Shifts in Metal Production by Five-Year Plans

	1950-1955	1955-1960	1960-1965	1965-1970	1970-1975
Shifts in production of rolled stock, pipe, semifinished products with metal wares, forgings from castings and ingots	24.0	15.4	21.0	11.0	5.0
Structural shifts of sheet and merchant rolled stock	13.5	10.8	17.5	1.6	5.4
Shifts in production of thin sheet, heavy sheet and skelp	30.0	24.4	20.0	12.8	10.0

It is noteworthy that more intensive internal shifts are occurring in the structure of sheet metal production. The ratio of sheet and merchant rolled stock is changing more slowly, but stronger shifts are taking place in individual kinds of rolled stock. For instance, in 1966-1978, when the total finished rolled stock production expanded by a factor of 1.7, the production of rolled stock from low-alloyed steel and of heat-hardened rolled stock increased 3-fold, bent profiles 7-fold, high-precision shaped profiles 20-fold. Since 1960, when the rates of growth of the production of ferrous metals slowed down, structural shifts in metal production have been accelerating, particularly in individual, most progressive rolled stock groups.

An analysis of structural shifts in metal consumption disclosed the following basic trends: 1) the proportion of castings in the structure of metal production is decreasing and the proportion of pipes, semifinished products and metal wares is increasing; 2) the proportion of merchant metal in the structure of rolled stock is decreasing and the proportion of sheet metal is increasing. The proportion of thin sheet, including cold rolled sheet, in sheet metal is increasing. By and large, however, the shifts are occurring comparatively slowly. The development of modern production dictates a need to accelerate the rates of expansion of economical kinds of metal.

Technical Progress and Efficient Structure of Metal Production

The development of progressive sectors of machine-building, the development of fundamentally new and the perfection of present constructions, the adoption of economical stamping and welding processes in place of casting, forging and milling, depend on the availability of metal of the appropriate quality and variety. Therefore the main task facing ferrous metallurgy is to improve the quality and selection of metal products in the interest of improving its utilization efficiency, i.e., formation of an efficient structure.

All measures that promote this in production are conditionally grouped into three main areas:

structural improvement of metal and rolled stock;

expansion of the variety of rolled metal products;

improvement of the quality characteristics of metal and manufacture of fundamentally new products.

There are no rigid boundaries between the above measures. They are closely related to each other and dovetail with each other. For instance, the production of steels with better performance characteristics and the adoption of fundamentally new metal production simultaneously promote expansion of the selection of rolled products. It should be pointed out here that all measures are aimed at improving the quality of metal products in the broad sense of the word, i.e., we define the quality of metal products as improvement of its physical, chemical and mechanical properties and expansion of its selection.

Let us examine in greater detail the measures we mentioned above.

1. Detailed economic calculations showed the structural improvement of metal production and rolled stock to be highly effective for the national economy. As we have already mentioned, the experts think it is possible in the near future to reduce the volumes of production and consumption of castings by 5-7 million tons annually by replacing castings with rolled products, by reducing the weight of castings by adopting precision casting techniques and by cutting back on the use of castings for molds and bed plates. The replacement of steel castings, when technically and economically justified, with welded sheet constructions will produce a savings of 103 rubles/ton (in terms of reduced costs). The replacement of 5-7 million tons of castings with rolled products can yield a savings of 500-700 million rubles annually on the national economic scale.

Structural rationalization and the current level of rolled metal products are characterized by an increase of the proportion of sheet (including thin and cold rolled), steel in rolls, bent profiles, by the number of intermediate sizes of sheet and merchant rolled stock, precision profiles and industrial metal products, the proportion of rolled stock with special properties and protective coatings, and heat-hardened rolled stock. Economical kinds of rolled stock are being developed in the USSR in recent years at faster rates than rolled stock of ordinary quality, new kinds of metal products have been adopted and the selection has expanded.

For instance, in 13 years (1966-1978), when the production of finished rolled stock increased by a factor of 1.7, the production of sheet increased 1.9-fold, including cold rolled 2-fold, and sheet metal with different kinds of coatings 1.7-fold. The proportion of these kinds of rolled stock in the structure of production increased accordingly. The proportion of sheet was 41.5%, compared with 37.8% in 1970, the proportion of thin sheet in sheet metal products remained about the same, and the proportion of cold rolled sheet in sheet metal production exceeded 17%, compared with 16%.

In spite of the progressive structural shifts that have been achieved in the makeup of rolled metal products and substantial improvement of the quality of ferrous metals, the demands of sectors of the national economy for economical kinds of metal products are still not being completely satisfied. Therefore the task of even greater expansion of the production of sheet metal products and thin sheet metal, including cold rolled, and substantial expansion of the selection of merchant profiles, i.e., radical improvement of the quality and expansion of the selection of metal products, was posed to the November (1979) Plenum of the CPSU Central Committee.

The accelerated development of industrial sectors that consume large quantities of sheet metal requires an increase of sheet metal production and corresponding structural change of rolled stock production. The use of sheet metal, including thin and especially cold rolled sheet, will provide a substantial saving. Indeed, the reduced cost of 1 ton of finished sheet metal products (rubles/ton) is approximately 20% lower than the cost of merchant stock. Therefore a structural change of rolled stock toward an increase of the proportion of sheet metal products, to approximately 50% instead of 40%, can produce a national economic saving of 1.5-2 billion rubles.

In addition to a shortage of sheet stock the economy is experiencing certain difficulties in connection with the limited selection of sheet stock and poor quality. The effective kinds of sheet stock are thin sheet, cold rolled sheet with a class one surface, wide rolled steel, dynamo and transformer steel, etc. The use of sheet metal in the form of wide rolls in the tractor and auto industry will cut metal consumption by 5-10% and save 9 rubles per ton[1]. The quality of sheet steel in rolls, in terms of tolerances, surface finish and mechanical properties, rolled

[1] The saving, in terms of reduced production cost and consumption of 1 ton of [illegible]roved-quality metal, was calculated at the Institute of Economics of the [illegible]ral Scientific-Research Institute of Ferrous Metallurgy.

on wide rolling mills, is better than that of individual sheets, rolled on ordinary mills. This improves the reliability of vehicles. Meanwhile the industry cannot yet meet the demand, for example, of the Soviet auto industry for wide-band rolled sheet steel, and part of the demand is met by importing the steel.

2. In comparison with the demand of the Soviet national economy the selection of merchant profiles is too limited, and it is being expanded comparatively slowly. The selection of merchant rolled stock as of 1 January 1977 consisted of 1,505 hot rolled profiles (in comparison with 1,340 in 1970 and 860 in 1960), and 900 general purpose and special shaped profiles. However, the demand of national economic sectors for these products outstrips production by a factor of 1.5-2, according to the experts' estimates. There are enormous opportunities in this area.

The selection of merchant rolled stock consists of simple and shaped profiles. The consumer wants rolled stock in a certain size and shape, closer in shape and cross section to the dimensions of parts. The selection of simple profiles in the USSR is characterized by inadequate dimensional variety. For example, in the case of 130 mm diameter and larger round steel and 110 mm and larger square steel sizes are available only in 10 mm increments, which sometimes necessitates the use of additional metal, turned into shavings, or increases the metal content of machinery. According to experience, the lack of necessary sizes for certain machine designs can lead to 2.5-15% overconsumption of metal[1]. Therefore it is advisable to increase the number of intermediate sizes for round, square, angle, sheet and strip steel.

The selection of thin wall shaped rolled profiles is still inadequate. Only half of the total shaped profiles are lightweight ones. In the selection of rolled stock of our country there is still a need to adopt and expand the production of considerable quantities of lightweight profiles and kinds of rolled stock necessary for the national economy, including wide-flange beams, variety of economical T-beams, I-beams, angle, tubular and other profiles. The production of lightweight rolled profiles will save a substantial amount of metal and produce a great national economic effect by virtue of more efficient size and shape and high strength indices. Lightweight shaped rolled profiles include wide-flange beams, the use of which will save 7-15% of metal in comparison with ordinary products, reduce construction labor cost and improve the performance reliability of metal structures. A multipurpose mill was placed in operation in the USSR in late 1977 at the Nizhne-Tagil' metallurgical combine, which in the 10th Five-Year Plan will produce 1 million tons of wide-flange beams to help meet a demand of 2 million tons[2]. The production and utilization of 1 million tons of wide-flange beams will save 150,000 tons of metal, and the annual saving will be 15.0 million rubles.

The demand of the national economy is growing for bent and calibrated profiles, shaped ordinary and precision profiles, periodic rolled stock, drawn wire,

---

[1]Sklokin, N. F., "Ekonomicheskiye problemy povysheniya kachestva i razvitiya sortamenta chernykh metallov" [Economic Problems of Quality Improvement and Development of Ferrous Metal Selection], Moscow, Metallurgiya, 1978, p 138.
[2]Tselikov, A. I., "Metallurgicheskiye mashiny i agregaty: nastoyashcheye i budushcheye" [Metallurgical Machines and Aggregates: The Present and Future], Moscow, Metallurgiya, 1979, p 87.

profiled pipes, fasteners and other economical forms of metal products. One of the most effective forms of metal product are bent profiles, the use of which will save an average of 10-30% metal and 40-45 rubles of reduced cost per ton by making the shape of the billets as close as possible to the shape of the final product. In 1978 plants of the USSR Ministry of Ferrous Metallurgy manufactured 1,353 thousand tons of bent rolled profiles, compared with a demand of 2,570 thousand tons. The average saving from using new shaped profiles is 40 rubles/ton, of which about 25 rubles/ton comes from the economization of metal and the rest from a reduction of labor costs, overhead and other costs to the consumer[1]. The demand for new merchant shaped rolled profiles, according to data of the Ukrainian Scientific Research Institute of Metals, is 1,600 profile sizes.

There continues to be a shortage of metal products in small sizes and cross sections. Metallurgical plants are known to be uninterested in manufacturing lightweight and efficient kinds of metal products, and this sometimes forces metal consumers to use heavier kinds of rolled stock. This entails the overconsumption of metal and sometimes adds unnecessary weight to the machinery and installations, which reduces the efficiency of the production and utilization of metal products, since it is necessary to expend extra materials, labor and money.

Economical new profiles continue to be adopted. In the last 5 years 532 rolled profiles were adopted, including 315 hot rolled and 217 cold rolled. A total of 500 new shaped profiles are supposed to be adopted in the 10th Five-Year Plan, including 300 hot rolled and 200 cold rolled. However, the demand of the national economic sectors for individual economical kinds of rolled stock still is not being met. At the same time the saving of metal in tons by expanding the selection of rolled stock is about one-fourth of the total savings from the implementation of all measures that promote improvement of the quality of metal. Therefore it is essential to speed up the expansion of the selection of rolled stock in order to more completely sat.sfy the demands of consumers and to save metal in the national economy.

3. Today the USSR national economy uses basically (75%) commercial hot rolled carbon steel with a yield point of 22-24 kg/mm^2, which does not meet all requirements (particularly on strength), imposed on modern metals. Machine-building and capital construction require higher-strength steels for parts that operate under especially severe conditions. Low-alloyed steels are considerably more effective because they are stronger (the yield point is 35-40 kg/mm^2) than carbon steels, have good plasticity, impact toughness and weldability and are resistant to corrosion. As a result machinery and constructions made of this steel are stronger and 15-30% lighter. Low-alloyed steel is used extensively in construction, automotive engineering, railroad car construction, excavator construction, gas pipelines, etc., which makes the constructions durable and reliable. The use of low-alloyed steels in place of carbon steels is extremely effective in structures constantly exposed to atmospheric corrosion. They have 1.5-2 times longer service life. The production of low-carbon steel rolled stock, in comparison with grade ST-3 killed carbon steel, increases the cost of rolled stock by an average of 10%

---

[1]"Byulleten' nauchno-tekhnicheskoy informatsii TsNIIChM" [Bulletin of Scientific-Technical Information TsNIIChM (Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin)], 1975, No 1, p 5.

and capital investments by 5%. At the same time the saving to the national economy is 21 rubles/ton due to a 20% saving of metal for the consumers.

The grade structure of steel production, due to the influence of scientific-technical progress, is changing toward a steady increase of the number of grades of steel, especially low-alloyed and alloyed. All this promotes an improvement of the fulfillment of the demand of the national economy for improved-quality metal. The production of low-alloyed steel is increasing at faster rates than that of carbon and alloyed steel. The production volume of alloyed and low-alloyed steel increased 4.8 times in 1958-1978 and will reach 24.4%, compared with 13.9% in the total structure of steel. The production of carbon steel increased 2.3-fold. And in the future it will be necessary to increase low-alloyed steel production at an advancing rate.

Much of the rolled stock goes to the consumer without the appropriate hardening in connection with a shortage of heat treatment capacities. Meanwhile the heat treatment of hot rolled carbon steel increases its yield point to 40-50 kg/mm^2, and up to 60-80 kg/mm^2 for low-alloyed steel. By and large heat treatment improves the performance indices of rolled metal (reliability, durability), reduces the consumption of metal in the products and reduces the metal content of constructions. Heat hardening of rolled stock does not require much additional cost. The price of rolled stock increases by 6 rubles per ton and additional capital investments in the construction of a heat treatment plant is 42 rubles. Saving the consumer 20-30% metal consumption will give the national economy a saving of 25 rubles/ton in reduced costs. The production of heat-hardened rolled stock in 1977 was approximately 6% of the total production, compared with 5.5% in 1975 and 4.2% in 1970. The demand of the national economy for this kind of rolled stock is substantially ahead of its production. The ferrous metallurgy industry cannot meet the demand yet because of the lack of the necessary heat treatment capacities. High rates of expansion of heat-hardened rolled stock production are planned in the future.

The production and consumption of plated rolled stock are extremely effective. For example, galvanized sheet metal products last approximately 3 times longer than ordinary sheet metal. Polymer-coated sheet metal saves the national economy 65 rubles/ton in reduced costs, aluminized sheet metal and other kinds of coatings save 40 rubles/ton. Today corrosion is reducing the structural strength and performance of many metal products due to the insufficient production of metal with coatings. Losses to corrosion account for about 10% of ferrous metal production. Losses to corrosion are especially great in the chemical, petrochemical, metallurgical and energy sectors and in transportation. The best way to protect machinery and to save metal in different environments is to systematically increase the production volume of rolled stock with protective anticorrosion, fire-resistant and wear-resistant coatings. The production of metal with coatings will increase: production doubled from 1960-1978. On the whole, however, the production volume of coated metals is 1,300 million tons, which is comparatively small in comparison with total rolled stock production. Plastic-coated sheet metal is being manufactured in insignificant quantities, and aluminized sheet metal is not yet available. The time has come to accelerate the rates and to increase the volumes of production of metal products with protective coatings, which will substantially improve the quality of metal. However, the corresponding capacities are necessary in order to increase the production of coated rolled stock.

The production of metal with certain prescribed properties is becoming increasingly important at the present time. This will be promoted by the development of special high-alloyed steels and alloys, pure, superpure and composite materials. More and more special precision steels and alloys are needed for the development of the electrical engineering, instrument engineering, radio electronic, electronic and other sectors of precision mechanical engineering.

Out-of-the-furnace refining and refining remelting -- electroslag, plasma arc, electron beam techniques are being used to impart purity and homogeneity to steel ingots, and the entire selection of quality steels is being poured under a protective canopy and with the molten slag. The melting of high-quality steel by the described techniques will increase substantially in the current five-year plan and in the future. These progressive technological trends in the steel-making industry will help to produce cast metal of high purity and homogeneity, which will produce a great economic effect. Electroslag remelting saves in reduced costs a total of 220 rubles/ton, steel melting in vacuum furnaces saves 67.5 rubles/ton, the treatment of steel with synthetic slags saves 20.5 rubles/ton and out-of-furnace vacuuming of steel yields a saving of 12 rubles/ton.

Powder metallurgy techniques are very important for the production of metals with prescribed properties. Powder metallurgy provides an opportunity to radically improve the properties of metals and by saving materials, money and labor, to achieve a significant economic effect on the national economic scale. Parts made of powders require virtually no mechanical processing and the utilization coefficient of the metal is doubled. Powder metallurgy essentially is a wasteless technology, a technology of the future.

The development of bimetals, i.e., combined materials consisting of several layers of different kinds of metals, is of great importance for improvement of the quality characteristics of metal and improvement of its strength and corrosion resistance. The requirements imposed by new technology on modern materials sometimes can be satisfied only by laminated materials. Bimetals especially enjoy extensive application in such sectors as atomic power engineering, jet and aviation technology, instrument engineering, shipbuilding, chemical and automotive engineering, petroleum and other industrial sectors. Bimetals save an enormous quantity of expensive and scarce metals and high-alloyed steels and alloys, reduce the weight of constructions, increase load-lifting capacity, reduce fuel and energy consumption, etc. The average saving of reduced costs is 180 rubles/ton. The high utilization effectiveness of bimetal makes it desirable to accelerate the production of this new and promising construction material.

Technical and Economic Conditions of Development of Efficient Metal Structure

Further improvement of the technical level of metallurgical production, the accelerated adoption and development of new technological processes, further intensification of production, the installation of modern efficient equipment and comprehensive retooling of obsolete shops and plants are essential for improving the quality and selection of metal products.

The quality of metal products depends especially on the technical and economic level of the steel-making and rolling industries. These conversions yield final products, which contain the labor costs of all previous metallurgical processes.

The cost effectiveness of the utilization of products in sectors of the national economy depends on the quality of the final products. The rolling industry and the so-called fourth conversion must provide the consumer with products that are finished to the maximum extent in order to promote an improvement of national economic effectiveness.

The most progressive equipment for melting higher-quality steel are converters and electric furnaces. Open hearth furnaces yielded 62.4%, oxygen converters 26.9% and electric furnaces 10% of the Soviet steel production in 1977. In the future the structure of the Soviet steel industry should be improved by increasing the proportion of steel from converters and especially from electric furnaces. Preference will be given to vacuum electric steel melting processes, electroslag, electron beam, plasma and other techniques that promote improvement of the quality of steel.

Expansion of the production of the economically effective method of direct reduction of iron from the ore will improve the quality of steel. In the Eighth Five-Year Plan several large semi-industrial installations were opened in the USSR for the production of sponge iron. Plants for the production of metallized pellets by means of the direction reduction of iron were placed in operation in the Ninth Five-Year Plan. Today construction is under way on a huge electrometallurgical combine, which will produce steel by this method on an industrial scale.

The quality of metal is improved by continuous pouring of steel, a process which was pioneered in the USSR. This sharply reduces metal wastes in the steel melting and rolling mills and substantially increases the final yield, saves 120 kg/ton of metal and increases labor productivity; fewer workers and capital investments per ton of steel are needed. The adoption of this method is proceeding, but not fast enough. In 1965 there were 17 continuous casting steel mills (UNRS) in operation with a total capacity of 1.35 million tons; in 1970 there were 35 UNRS in operation with a capacity of 5.7 million tons, and in 1978 UNRS were casting 12.4 million tons of steel. However, high efficiency demands substantially greater expansion of the adoption of UNRS. Continuous casting facilitates the realization of the concept of metallurgical process continuity and intensification. Today ferrous metal production technology is characterized by process continuity with two liquid phases -- blast furnace and steel mill. This entails repeated cooling and heating of the metal, involves additional expenditures of energy and metal and adversely affects the quality of the steel. Therefore one of the central tasks in relation to improvement of ferrous metallurgy technology is to convert to the continuous process. A continuous casting steel mill is undergoing tests at the present time. The industrial adoption of this production process will provide an opportunity to combine all processes, from the melting of the iron to rolling, into a single cycle.

The quality of metal products depends not only on the last conversions, but is also determined by the engineering and technological level in all stages of metallurgical production. The quality of metal is also influenced by the quality of the raw material. Reduction of impurities (sulfur, silicon and other elements) and stabilization of the composition of the iron are very important. Agglomerate and pellets have begun to be used extensively in iron production in recent years. This made it possible to increase the productivity of the blast furnaces, reduce the

specific consumption of coke and improve the chemical composition of the iron. The quality of metal depends most on the utilization of metallized pellets. Therefore their production is growing at accelerated rates: 30.0 million tons in 1977, compared with 10.6 million tons in 1970 and 0.3 million tons in 1965, and their production will increase 2.3-fold in 1980.

Analysis of the basic technical and economic measures, aimed at improving the quality of metal and at the development of new kinds of metal products, proved them to be highly cost effective and demonstrated the possibility that they can be adopted considerably faster than metal production can be expanded. Therefore measures should be taken to increase the quality and to expand the selection of metal products at a faster rate, especially since there are tremendous reserves in this area.

By and large numerous economic calculations (and our own data) show that it is about twice as cheap to improve the quality and structure of metal production than to increase the production of metal of the usual quality. Consequently capital investments in the advancing development of rolled metal production and in subsequent finishing processes are approximately twice as profitable as investments in the development of new capacities in the entire metallurgical cycle, beginning with the mining of ore and coal. The adoption and development of such technological methods as the production of high-precision shaped profiles, electroslag remelting, thermomechanical hardening of rolled stock, the production of electron beam sheet iron instead of hot tinning, and the production of bimetals, produce the greatest saving in terms of reduced costs of the production and consumption of 1 ton of improved-quality metal. The total saving will depend on how much metal is produced by these techniques. Large-volume production methods -- heat hardening of rolled stock, low-alloyed steel production, treatment of steel with synthetic slags, manufacture of cold rolled sheet and cold drawn merchant steel, etc., usually give the highest total saving. However, the specific per ton cost effectiveness of these kinds of metals is comparatively poor.

According to calculations the proportion of savings due to the utilization of more economical metal is increasing: 33.2% in 1971-1975 in comparison with 15.2% in 1966-1970. About the same percentage of savings (32.6) is expected in 1976-1980. In the 10th Five-Year Plan the saving of ferrous rolled stock in machine-building and metallurgy will be 14-16% and in construction it will be 5-7%. Special attention is being devoted to the need to improve the quality of metal products and to expand its variety. Advanced growth rates are planned in the production of high-quality metals: the production of finished rolled stock will be increased by approximately 1.2-fold, and the production of efficient kinds of metal products will be increased 1.5-2-fold. Cold rolled sheet metal, coated sheet stock, bent profiles, heat-hardened rolled stock made of low-alloyed steel, sheet stainless steel and cold rolled transformer steel and cold rolled strip will be produced at accelerated rates.

To intensify high-quality metal production processes it is essential to elevate the engineering level of ferrous metallurgy, for which the following are important: 1) acceleration of the rate of replacement of the most worn out equipment; 2) faster development and adoption of new and economical metal production capacities; 3) improvement of the technical-economic parameters of new equipment; 4) perfection of the system of planning and stimulation of high-quality metal production.

One of the basic factors on which quality depends is the technical level of production. The technical level has been elevated and metallurgical processes have been intensified considerably in recent years. During the Ninth Five-Year Plan, for instance, 6 large blast furnaces, 6 oxygen converters and 6 electric furnaces, 13 new hot rolling mills, 2 cold rolling mills, 8 pipe mills, a large bent profile plant, an electrolytic tinning plant and a sheet steel polymerizing plant were placed in operation. As a result there was an improvement of the capital-labor ratio of the workers, which not only affects labor productivity, but also provides opportunities to manufacture products of higher quality.

However, much of the metallurgical machinery that is presently in operation needs to be replaced, since its technical and economic parameters do not meet the modern requirements of scientific-technical progress and it is difficult if not impossible to manufacture high-quality metal products with it. According to available data, approximately 20% of the rolling mills are physically obsolete. In connection with the rapid rates of scientific-technical progress, the existing equipment is also subjected to accelerated wear. But for practical purposes retooling is not only not being sped up, it is even slowing down. In 1978, for instance, the retirement rate of machines and equipment in ferrous metallurgy was 1.3%, compared with 1.7% in 1975. Outmoded equipment produces metal of poorer quality, labor productivity decreases several fold and production costs increase. With obsolete equipment it is not possible to manufacture rolled stock with the required precision or to achieve negative tolerances and high-quality surface finish.

The existing industrial capacities of ferrous metallurgy are still inadequate for the production and fulfillment of the demands for high-quality metal. Sheet rolling mills, rolled stock finishing mills for applying protective coatings and for heat treatment of metal, continuous steel casting machines and other kinds of equipment are necessary in order to increase the production volumes of metal with improved quality in ferrous metallurgy. The development of the necessary equipment for the fourth conversion is one of the basic tasks facing metallurgical machine-building.

Improvement of the quality of metal requires equipment with the corresponding technical and economic indices. Unique blast furnaces and large converters have been built and highly productive rolling mills and hydraulic presses have been installed in the Soviet Union during the last 5 years. This has made it possible to export certain kinds of metallurgical machinery to industrially developed countries. Meanwhile the engineering level of some kinds of metallurgical aggregates does not meet modern requirements of technological progress and improvement of the efficiency of social production in terms of such indices as precision, level of automation and productivity. For example, basically obsolete plants are being used in the Soviet Union for heat treatment, and highly productive automated furnaces are more efficient.

By virtue of modern progress in science and technology there are many opportunities for efficient production and consumption of material resources. Many of them are already in use in industrial processes and some are in the adoption stage. However, the rates and scope of the adoption of scientific and technological progress are still inadequate. The organizational-structural level and the system of planning and stimulation of production and consumption of material resources are the delaying factors.

The structure of capital investments in ferrous metallurgy must be perfected more decisively in order to intensify the production and consumption of ferrous metals. Up until now most capital investments are aimed at increasing ferrous metal production and too little is being invested in rolling and finishing production: 41.7% in the Ninth Five-Year Plan and 44% in the 10th Five-Year Plan out of the total capital investments in ferrous metallurgy, compared with 50-60% in the industrially developed countries.

The existing system of planning, evaluation and stimulation of the production of ferrous metals in tons and in terms of the volume of realized production "from the attained level" forces workers of the metallurgy industry to make heavier and more metal-consuming rolled stock. Prices are also figured in tons without due consideration for production quality. All this is delaying the adoption and production of new economical profile rolled stock.

Implementation of the resolution of the CPSU Central Committee and USSR Council of Ministers "On improvement of planning and strengthening of the economic mechanism to increase production efficiency and quality" of 12 July 1979, which calls for a system of measures for further improvement of planning management and stimulation of the development of socialist economics, will promote the accelerated adoption of new and highly economical production. The pure production quota index is being put into effect for the purpose of planning and assessing the production and economic activities of industrial ministries, associations and enterprises. This index contains just the work of a given enterprise, with the result that any interest in increasing the material consumption of production at the expense of product utility and versatility is eliminated. The importance of pricing is increasing in the expansion of the production of high-quality goods: incentivation add-ons to the wholesale prices of new high-quality products that match the best Soviet and foreign counterparts in terms of parameters, are being increased and penalties for the manufacture of obsolete products are being strengthened. The total add-ons and discounts are not taken into account in the plan, but the fulfillment of the plan is evaluated with them in mind.

The corresponding changes are to be incorporated in the system of natural indices (for example metal in tons) for analyzing productivity in ferrous metallurgy (and in other industrial sectors) on the basis of the extensive application of scientifically sound technical-economic data, which make it possible to take into account the efficiency, quality and other consumer properties of production.

The expeditious implementation of the examined measures will have an important effect on improvement of the structure and quality of metal products, which will facilitate an improvement of the effectiveness of metal consumption.

[18-7872]

7872
CSO: 1842

GLASS AND CERAMICS

UDC 539.411:620.173:620.174:666.1

ON THE QUESTION OF THE INFLUENCE OF WORKING MEDIA ON THE STRENGTH OF INDUSTRIAL GLASS AND SITALL

Kiev PROBLEMY PROCHNOSTI in Russian No 9, 1980 pp 84-86 manuscript received 10 Dec 79

POLESHKO, A.P., Institute of Problems of Strength, UkSSR Academy of Sciences

[Abstract] A study was made to analyze the influence of sea water on the strength of glass and sitall in the industrial delivery condition and after ion exchange hardening. Specimens were tested both in sea water and in air after extended exposure to sea water. It was found that prolonged exposure to sea water has virtually no effect on the mechanical properties of industrial glass and sitall, either in the raw condition, or after ion exchange hardening, but bending tests in sea water showed a 40 percent loss of strength. STL-10 sitall with high and stable strength in air and great resistance to sea water was found preferable for the development of bearing structures. References 6: all Russian.
[4-7872]

MECHANICAL PROPERTIES

UDC 621.791.72

MECHANICAL PROPERTIES OF ELECTRON-BEAM WELDED JOINTS BETWEEN STRIPS OR PLATES OF 1201 ALUMINUM ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 80 pp 49-51 manuscript received 8 Feb 79, after final revision 7 May 79

BONDAREV, A.A., candidate of technical sciences, and TRETYAK, N.G., engineer, Institute of Electric Welding imeni Ye.O. Paton, UkSSR Academy of Sciences

[Abstract] Joints between 5--40-mm-thick strips or plates of 1201 aluminum alloy were produced by electron-beam butt welding, with the specimens in a vertical position and with a single pass of a horizontally focused electron beam moving at a rate of 70 m/hr under an accelerating voltage of 60 kV. These joints were subsequently tested at three temperatures: -196, +20 and +200°C. Measured were their hardness, ultimate strength, 0.2 percent yield strength, percent elongation, percent area reduction, toughness and bending angle. Some specimens were neither heat treated before nor after welding; other specimens were only quenched or quenched and artifically aged before welding. In both cases they were either not heat treated or were only artifically aged or quenched and artifically aged after welding. Heat treatment of the members before welding was found to make some difference in the properties of the seam, except in the properties at -196°C and in the effectiveness of artificial aging after welding. The properties of the welding seam were also found not to depend much on the thickness of the members.
Figures 3.
[189-2415]

NONFERROUS METALLURGY

NEW METHOD IN NONFERROUS METALLURGY DESCRIBED

Moscow EKONOMICHESKAYA GAZETA in Russian No 32, Aug 80 p 15

[Article by A. Vanyukov, doctor of technical sciences, professor, and V. Bystrov, doctor of technical sciences, professor: "Smelting in a 'Liquid Bath': A New Method for the Comprehensive Processing of Raw Materials in Nonferrous Metallurgy"]

[Text] In the metallurgy of heavy nonferrous metals, one processes raw materials which contain, as a rule, in addition to copper, a large quantity of nonferrous, rare, and noble metals. The basic minerals in these raw materials are usually sulfides -- compounds of various metals with sulfur. In the process of smelting, as they are burned up, they produce heat. Metallurgists view them as an energy-producing fuel. In addition, nonferrous metals and iron which are contained in sulfides constitute many, many million tons. And they also can be obtained. However, only a small part of the metals is currently being extracted from ores. By way of an example one can indicate the following: of the copper ores mined in a shaft or quarry, only an insignificant part of the raw material is converted to processed concentrates at special concentration plants. During the metallurgical processing of these concentrates, one obtains metals and other types of output. The bulk of the ore extracted from the ground is irreversibly lost.

The essence of the most widespread methods of smelting copper lies in the heating of the initial raw material and the smelting of it by relying upon electrical energy or the burning of carboniferous fuel. In the furnace, two mutually insoluble layers of the melt are formed. The copper and other valuable components being extracted collect in the lower layer, which is called the matte, and which is then sent on its way for further processing. The rest of the initial materials is discarded in the form of waste gas or the upper layer of the melt, which is called the slag. The extraction of valuable components from it has, until the present time, not been profitable.

However, in the past decade questions that have become more acute are those dealing with the economizing of material resources and the protection of

the environment against pollution. That has forced scientists and production specialists to search for new ways to process metallurgical raw materials.

In the 1950's and 1960's a method was developed and introduced into industry abroad and in the Soviet Union -- a method of processing pulverized sulfide copper and nickel concentrates in suspended state. With the aid of that method it was possible to reduce the expenditure of carboniferous fuel and, in addition to nonferrous metals, to extract from the raw materials a considerable amount of the sulfur, thus reducing the amount of sulfur discharged into the atmosphere. In this version, as much as 40 percent of the bulk of the raw materials being processed is extracted as useful output.

At the same time, shortcomings in the new method were also noted. The appearance in the raw materials of admixtures of zinc or of components that are difficult to melt leads to a sharp reduction in technology. In addition, a considerable quantity of the processed raw material containing ferrous metals becomes storable by-products of production. Practical life indicated that it would be impossible to get rid of these shortcomings by using the old technology.

The Soviet Union is conducting intensive theoretical research and industrial tests involving the smelting of sulfide raw materials of heavy nonferrous metals in the slag melt. The version of progressive technology which was proposed at the Department of the Metallurgy of Heavy Nonferrous Metals, Moscow Institute of Steel and Alloys, has been given the name of smelting in a "liquid bath." The new method is being developed with the participation of scientists at the branch institutes of the USSR Ministry of Ferrous Metallurgy; Academy of Sciences, Kazakh SSR; production specialists at the Noril'sk and Balkhash Mining and Metallurgical Combines; and other institutions. It has successfully undergone semi-industrial and experimental-industrial tests and is currently being used in production.

Smelting in a "liquid bath" represents a fundamentally new emulsion process of metallurgical conversions, a process which, as a result of its advantages, can find broad application in many branches.

Wherein lies the essence of the new method? Scientists and specialists have found a method of feeding oxygen through tuyeres into the furnace where the smelting is in progress and where the temperature of the slag reaches 1350° C. That made it possible to intensify the process by tens of times. The raw material is loaded through the furnace crown. The size of the particles can be from several microns to 10 centimeters (in the new technology, no special preparation of the furnace charge is required). As they strike the boiling slag that is being mixed with the oxygen, the particles of the furnace charge sink in it and within a few seconds are smelted. The particles of copper sulfide do not combine with the slag, but, rather, "swim" in it like a drop of oil in water. They are immiscible

liquids. But the particles of homogeneous metal -- for example, copper, nickel, and others -- fuse together and, as heavy drops, pass through the slag, forming under it a layer of matte, which is continuously removed from the furnace.

When smelting in a "liquid bath," the content of copper in the slag, even without special depletion, constitutes only 0.5-0.6 percent, whereas in the matte the content is as much as 60 percent. No other technology provides such impressive results. The use of oxygen blowing in the new technology makes it possible to obtain, in the process of oxidation of the sulfides, heat that is sufficient for "self-support" of the smelting without the expenditure of fuel.

Moreover, although the discharge of waste gases is reduced to a very considerable extent, those gases are valuable and contain as much as 60 percent of sulfur dioxide, from which the sulfur can be extracted with the aid of methods that have already been assimilated in industry. The high extraction of copper, nickel, and other valuable metals, and the high productivity, indicate the considerable advantages of the new emulsion technology. These achievements have already been obtained on an industrial scale. This explains the large amount of interest being shown to the new process by production experts at those enterprises where the tests were carried out. Actually, the specific productivity of the furnace for smelting in a "liquid bath" exceeds the productivity of a reverberatory furnace by a factor of 15. It is also necessary to take into consideration the fact that the workers' labor conditions are greatly facilitated.

It is necessary to emphasize particularly that the technical indicators for smelting in a "liquid bath" which have been achieved in the Soviet Union substantially surpass the performance data for the best foreign processes. For example, when smelting with the method used by the Canadian Noranda Company, the specific productivity is one-eighth, the transfer of the copper to the slag is almost 10 times greater, and the quantity of the waste gases is 2-3 times greater.

However, the high technical-economic indicators were obtained during experimental-industrial tests. Therefore, there are great opportunities for the further improvement of the effective technology. A number of proposals have already been made, verified in laboratories, considered, and defended by originators' certificates [Soviet patents]. Those proposals make it possible to increase the content of copper and nickel in the matte, to increase their extraction, and to reduce the content, for example, of copper in the slag to 0.2-0.3 percent. It is necessary on an urgent basis to bring them up to the level of industrial technology and to introduce them into production. One possibility that opens up great prospects is that of using emulsion technology to process copper-zinc and complex polymetallic raw materials.

In this instance a problem that is completely resolvable is that of extracting iron from slags of polymetallic ores and the use of silicate compounds, for

example, as building materials. These operations are being conducted successfully at the Institute of Chemistry and Metallurgy, Academy of Sciences, Kazakh SSR. Active work has been begun to use the new method in ferrous metallurgy. At the November Plenum of the CPSU Central Committee (1979), L. I. Brezhnev pointed out that one of the chief reasons for the shortage of metals in our country is the fact that fundamental, qualitative changes in metallurgy itself are being carried out slowly.

The new method of processing raw materials of heavy nonferrous metals -- smelting in a "liquid bath" -- is a fundamentally new approach to the resolution of a number of metallurgical problems. The situation requires the planning of the development of research on emulsion technology on a massive scale, at high rates, and along a broad front. That will provide the opportunity to obtain rapidly a considerable economic benefit, to increase the comprehensiveness of the use of the beneficial components of the raw materials, and to achieve a substantial reduction in the pollution of the environment by waste products in the production of nonferrous metals. [1-5075]

5075
CSO: 1842

NONFERROUS METALLURGY OF TAJIKISTAN: CONCERNS, PROBLEMS, PROSPECTS

Dushanbe KOMMUNIST TADZHIKISTANA in Russian 18 Oct 80 p 2

[Article by P. Lomako, USSR minister of nonferrous metallurgy]

[Text] Recently the USSR Minister of Nonferrous Metallurgy Petr Fadeyevich Lomako was in our republic. He visited the Tajik aluminum plant, he met with the directors of the other branch enterprises, he made recommendations with respect to improvement of the work of a number of enterprises. Some of his impressions and suggestions are discussed in this article.

Since ancient times precious metals, gems, lead and copper have been extracted in Tajikistan. However, in the middle ages the deposits known at that time had been already exhausted, and the mines fell into ruin. Intense and planned study of minerals began only after the Great October Revolution. During the years of the first five-year plans, numerous deposits were prospected and turned over to the mining industry. At the present time lead and zinc, mercury and antimony, copper, tungsten and molybdenum, bismuth and cadmium, strontium and fluorspar are extracted...

In the "basic areas of development of the national economy of the USSR in 1976-1980" approved by the 25th CPSU Congress, it was provided that in the Tajik SSR the industrial production would be increased in volume with leading development of electric power engineering, nonferrous metallurgy and the chemical industry. The attention of the party and the government to the development of the nonferrous metallurgy in Tajikistan indicates the great significance of the branch not only on the scale of the republic, but also on the scale of the entire country.

Summing up the results of what was done in the five-year period, the miners and metallurgists can with full justification state that the missions stated by the party have been accomplished. This year alone the enterprises of nonferrous metallurgy together with the enterprises of power engineering will provide 51% increase in industrial production generated in the republic.

The extraction of useful minerals in Tajikistan is basically being conducted by the underground procedure. This is dictated by the mining and geological conditions of occurrence of the majority of deposits. The improvement of the extraction technology, the application of the complex of machines and mechanisms created in recent years has made it possible to increase the intensity of the working of the deposits, it has provided significant growth of the productivity of labor. With respect to

the mines of the Adrasmanskiy lead and zinc combine the productivity of labor has increased on the average by 37%, in the underground operations in the Chorukh-Dayronskiy mining administration, by 44%, in the Anzobskiy mining and enrichment combine, by 27%, and in the Takobskiy fluorspar combine by 40%. The figures are impressive.

The measures directed at improvement of production and improvement of the productivity of labor at the mining extraction enterprises of the branch have become a good engineering base for the development of socialist competition. Its glow has grown from phase to phase, and now at the end of the five-year plan it has turned into a mass movement under the motto "26 shock weeks for the 26th CPSU Congress!" The shock precongress watch was an important mobilizing factor in the fulfillment of the high socialist obligations, finding intraproduction reserves and activation of them. It is possible to find many confirmations of this at the branch enterprises.

The challenge Red Banner of the USSR Ministry of the Nonferrous Industry of the Central Committee of the Trade Union of Workers of the Metallurgical Industry have noted the production progress of the collective of the Anzobskiy mining and enrichment combine and the Central Asian Geological Exploration Expedition. A great contribution to the labor achievements of the mercury and antimony miners has been made by the advanced brigades of drillers, hero of Socialist Labor Alim Nazimov and drift miner Aleksandr Gigor'yevich Malinovskiy.

The brigade of A. Malinovskiy had already fulfilled the five-year plan in June of last year, and the brigade of A. Nazimov reported the achievement of this goal on 2 April 1980. The advanced collectives headed up the competition for early completion of the assigments of the Lenin celebration year by 7 November. The drillers were obligated to make 1560 running meters of additional hole, and the drift miners, to drift 112 meters of mining operations above the plan.

This initiative was taken at the combine by the workers of many professions -- the drift miners, pumpers, drillers, driers, and the dump truck drivers. Summing up the work of all of the brigades, it is easy to understand where the collective of the Anzobskiy mining and enrichment combine, which had adopted very responsible obligations -- to complete the tenth five-year plan by 1 December -- found its reserves.

The planned assignment with respect to ore extraction and the production of copper concentrate has been exceeded by more than four times by the collective of the Chorukh-Dayronskoye ore directorate. The plan has also been exceeded with respect to the production of tungsten industrial products, molybdenum concentrate, and vanadium-aluminum ligature. Here the rhythm is set by the mines which are the head of the technological chain. The advanced brigades of the mining enterprise headed by N. Khamzinyy, A. Filinov, A. Akhmerov, were obligated to fulfill the plans of the first quarter of 1981 by opening day of the 26th Party Congress. An excellent start, a strong foundation for successful work in the new five-year plan!

It is important to note the trend defined during the course of the pre-congress competition and characteristic of all of the collectives of the nonferrous metallurgical enterprises of Tajikistan. This is an effort to convert the highest achievements of the shock time to the daily indexes of the forthcoming five-year plan. The party organizations have aimed the miners, the concentration specialists and metallurgists at this goal.

It is especially necessary to talk about the labor progress of the collective of the Tajik aluminum plant. The current five-year period is the first in its history. The metallurgists of Tursunzade began the working biography of this enterprise with systematic overfulfillment of the assignments. Since March 1975 when the first metal was obtained, the plant has increased capacity steadily, and now it rightfully plays one of the leading roles in the aluminum industry of the country.

The Tajik aluminum plant has become a type of experimental test area where new equipment and processors, the latest developments in the field of aluminum production are tested.

Together with the scientists and the designers of the All-Union Aluminum Institute, the enterprise has assimilated the intensified electrolysis regime. Here the lowest electric power consumption and lowest consumption of fluorine salts for aluminum production has been achieved. The most powerful electrolyzers in the country have been built. The only large-scale anode production facility in the country has been assimilated here. More than 90% of the plant production is with the State Symbol of Quality. In all of the shops the production processes are distinguished by a high level of automation and mechanization, insurance of environmental protection and the creation of conditions for the fruitful work of the people.

Behind all of these facts is the creative, intense work of the collective which is successfully completed in the five-year plan. In socialist competition such recognized masters of their business as electrolyzer brigade leaders Yu. Kharlitskiy, T. Aslanov, V. Zakharov and founder G. Pivtsayev are without equal.

By the initiative of the collective of the brigade headed by Tel'man Aslanov, socialist competition has been developed for early assimilation of the design capacity of the electrolysis unit No 8. This problem has been successfully solved so that for the electrolysis workers of the Tajik aluminum plant the year of 1980 has been marked by early bringing of new units to their design capacity. Now the equipment for the ninth unit is being accepted and tested. By the opening of the 26th CPSU Congress it will be producing metal. Another important step in the building of the Tajik aluminum plant will be completed.

Along with the assimilation of new production facilities and the technological process for the branch, a very important achievement made at the plant is the creation of a multithousand labor collective. The plant is in a zone of traditional agricultural production where there have been no large industrial enterprises, especially no metallurgical enterprises. Accordingly, it has been necessary to overcome defined difficulties in forming the collective.

Its backbone became the experimental workers, engineers and technicians arriving from the related enterprises of the country. It is difficult to overestimate the contribution of these people who have borne the main weight of the work during the startup and the assimilation of the production capacities. The republic has recognized many of the specialists by awards. Thus, electrolysis shop chief Ye. N. Popov received the rank of "Honored engineer of the Tajik SSR," the Honorary Certificate of the Presidium of the Supreme Council of the Tajik SSR was awarded to electrode production shop chief V. A. Petrov, and the rank of "Honored Inventor of the Tajik SSR" was awarded to chief engineer of the plant A. N. Kurokhdin for excellent innovative contributions t the mastery of production.

hundreds of qualified industrial and engineering and technical workers among the representatives of the basic nationality have been trained during the period of operation of the plant with the help of veterans of nonferrous metallurgy. The proportion of the industrial personnel of the plant out of the total local population today is 63.3%. More than half of the workers in the leading professions -- electrolyzer operators, anode operators, founders, annealed anode production technologists -- are local young people, the children of cotton growers and animal husbandrymen.

This is characteristic not only of the Tajik aluminum plant, but also other enterprises. Today in the mines and at the enrichment plants, together with the Tajik Uzbek and Russian people, more than 40 other nationalities are working shoulder-to-shoulder. Internationalism, fraternal friendship -- these are the most valuable alloys crystallized at the nonferrous metallurgical enterprises of Tajikistan.

Here I should like to develop an idea stated at the very beginning of this article, about the role of nonferrous metallurgy in the development of the republic. In estimating the significance of this role, the party and economic developers of Tajik SSR are unanimous. Indeed, they say that the branch will make a great contribution to the development of the productive forces of the republic. As a result of it, there has been a change toward better social-economic conditions of labor, the number of working class has increased, and the cultural level of the population has been raised. This is in addition to producing a most important product for the industry of the country. In particular, one of the most important factors of creating the southern Tajik Territorial-Production Complex has become the construction of the aluminum plant, the successful activity of which is creating economic possibilities for the formation of other complexes, for concentration and specialization of production.

The growth of the large collective is connected with defined difficulties. It is necessary to note that the turnover rate of the personnel is quite high here. Sociological studies have demonstrated that the cause of the turnover in the majority of cases is the dissatisfaction with living conditions, medical service, transportation, and the operation of the educational and trade institutions. I think that the successful solutions of this problem is in the interest not only of production collectives. The problems connected with it must be under rigid supervision of the city, oblast and republic party and Soviet agencies.

The future of the branch, successful activity in the eleventh five-year plan and in subsequent years will to a great extent depend on the solution of a number of problems. The prospects of the Tajik aluminum plant are directly connected with rhythmic and high-quality operation of the Tadzhikgidroenergostroy trust, which is building up the industrial site in Tursunzade. We are also placing much hope in the activities of the "Seventeenth Agreement," which was signed by the designers, builders and maintenance people -- all participants in the construction of the plant, obligated to see that everything that depends on them is done for success of the operations. The enterprise collectives will in the eleventh five-year plan continue to improve the equipment and the aluminum production process on the electrolyzers with high-power annealed anodes, and it will significantly increase the high-grade metal production. The power reserves of Soviet Tajikistan are enormous, which permits a "great aluminum" future for our country.

The development of the metallurgical enterprises of the branch is wholly connected with the solution of the most important problem -- provision of them with raw material. The intense working of the ore deposits, correspondingly, will lead to a reduction in the ore reserves. Now the problem of making up the raw material base is urgently facing the Takobskiy fluorspar combine, the Adrasmanskiy lead-zinc combine and the Chorukh-Dayronskiy mining directorate.

Geologists of the Central Asian geological exploration expedition of the USSR Ministry of Nonferrous Metallurgy are prospecting the flanks and the deep horizons of the Takobskiy and other deposits. The results of their work are hopeful. There is ore. It is necessary that the geology directorate of the Tajik SSR speed prospecting work in the Karamazarskiy ore district in the Kansay, Shaptaly and other exploitable deposits. The number of possibilities of Tajikistan have far from been exhausted. Further intensification of the geological exploration work will undoubtedly lead to the discovery of new industrial deposits of nonferrous, rare and other metals.

Convincing confirmation of this is the growth in the republic of the gold-extracting subbranch. Whereas a few years ago the expediency of creating a specialized enterprise with respect to the exploration and experimental operation of the deposits was questioned, today as a result of the exploration and prospect work the necessity has arisen for realization of the prospecting and exploitation of Tadzhikzoloto gold enterprise into a production association and the construction of new mines and enrichment plants. This marks only the beginning of a new phase of industrial exploitation of the minerals of Tajikistan.

Building up the volumes of production, the prospecting and exploiting Tajikzoloto gold enterprise has fulfilled the five-year plan with respect to increasing reserves in four years. Today the mineral prospectors are working toward the account of the eleventh five-year plan.

Very great and theoretically new progress in the development of the raw material base of the gold extracting industry has been made in the current five-year period by the collective of the geology directorate of the Tajik SSR. The geologists have discovered and prepared new deposits for exploitation; they have successfully protected the metal reserves with respect to the Tarorskiy deposit, which permits the beginning of forced construction of the mining and enrichment combine.

In recent years by the joint efforts of the geological exploration organizations of the USSR Ministry of Nonferrous Metallurgy and the USSR Ministry of Geology, the prospects of a number of known deposits of nonferrous, rare and other metals have been significantly expanded, which dictates the necessity for reconstruction of the existing mining enterprises.

At the same time we have forced the USSR Ministry of Geology to turn its attention to the entirely inadequate rates of prospecting and exploration of placers, the industrial exploitation of which can be quickly realized with small capital investments.

The areas of the Pamir-Alay mining system appear to be highly prospective where the forces of the geology directorate of the Tajik SSR must quickly perform detailed purposeful prospecting.

The proposals of the Tajik SSR Council of Ministers on the creation of an integrated mining combine in Northern Tajikistan for working the known, shallow deposits of nonferrous and other metal ores and the construction of a rayon enrichment plant with a branched technological flow chart to insure all-around use of the mineral raw material and completeness of depletion of the explored mineral reserves deserve serious technical and economic development.

In a word, the mining industry working the deposits has every possibility for intense development in the republic.

Nonferrous metallurgy -- an important branch of industry in Soviet Tajikistan is gathering strength. I should like to see the local party and soviet workers jointly with the USSR Ministry of Nonferrous Metallurgy give greater attention to the training of national personnel. In the example of the aluminum plant it is obvious what a good place for the application of forces the enterprises of nonferrous metallurgy could become for the komsomol members. Who but the young should develop a young branch! The goal of the republic komsomol is to help the young men and women to find the path to it.

The development of science and engineering is at a fast pace. In many areas of technical progress the metals extracted from the depths of mountainous Tajikistan and refined in its furnaces are performing a reliable service. The metallurgists of the republic are making a weighty contribution to the development of the industry of our homeland!

[20-10845]

10845
CSO: 1842

UDC 621.762.27

A NEW METHOD OF PRODUCING SINGLE-CRYSTAL ALUMINUM POWDER WITH A HIGHLY DEVELOPED PARTICLE SURFACE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 8 (212), Aug 80 pp 13-18 manuscript received 1 Mar 80

STOROZHENKO, V.N., Dnepropetrovsk Institute of Chemical Technology

[Abstract] The paper describes a method of aluminum powder production patented by the author [Soviet Author's Certificate No 548379, Patent Bulletin No 8, 1977, p 42]. In contrast to electrolysis, this technique does not require current rectifiers, electric lines, instrumentation for regulating and monitoring direct current or two separate electrodes. The process does not use direct current, and the functions of anode and cathode are performed by a single bipolar electrode. The method uses an electrolytic concentration cell with a two-layer molten electrolyte made up of $AlCl_3$ and either KCl, NaCl or a mixture of the two. The $AlCl_3$ concentration differs in the two layers. The lower layer is saturated with Na(K)Cl to an excess in the solid phase, and the upper layer has an elevated concentration of $AlCl_3$. The cell works on internal energy. Gravitation keeps the layers separated due to the difference in densities of the melts. An aluminum specimen immersed in both layers of electrolyte acquires a more negative potential in the lower layer. The cell begins operating to balance the $AlCl_3$ concentration in the layers, i.e., anodic dissolution of aluminum takes place in the lower layer, while cathodic crystallization takes place in the upper layer. The operation requires periodic or continuous adjustment of the composition of the salt layers to prevent balance. Under laboratory conditions, powder in the form of single crystals with preferred faceting by planes [111] was produced with a specific surface of about 10^4 cm^2/g and bulk density of about 0.23-0.3 g/cm^3. Purity was from 99.57 percent to 99.99 percent, depending on the type of equipment used. Productivity and particle size are increased by raising the temperature of the process. Particle size is also increased by raising the concentration of $AlCl_3$ in the upper layer of the electrolyte and by increasing the time of operation. Figures 5; references 6: 5 Russian, 1 Western.
[186-6610]

UDC 022.346.3

INVESTIGATION OF THE GROWTH OF WEAR-RESISTANT TITANIUM CARBIDE LAYERS ON HARD ALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 8 (212), Aug 80 pp 48-52 manuscript received after revision 1 Mar 80

PLATONOV, G.L., ANIKIN, V.N., ANIKEYEV, A.I., ZOLOTAREVA, N.N., NALIMOVA, M.N., CHEBURAYEVA, R.F., KUZNETSOVA, K.F. and TOROPCHENOV, V.S., All-Union Scientific Research and Design Institute of Refractory Metals and Hard Alloys

[Abstract] Titanium carbide is widely used to produce a wear-resistant surface on hard alloy cutting tools by deposition from the gas phase. In this paper the authors study the effect of the time of the growth process on the structure and composition of such carbide layers. TT10K8B alloy specimens were studied. Optimum conditions were used: temperature of 1050°C, $TiCl_4$ flowrate 14-15 g/hr, CH_4 flowrate 3.2 liters per hour, ratio of Ch_4 to $TiCl_4$ 2.0-2.5, gas velocity 5-6 cm/s, hydrogen flowrate 230 liters per hour. Structure was studied under an optical microscope, and composition was analyzed by a method of etching and staining. The lattice constant was determined from the x-ray diffraction pattern. The layer was found to consist of polycrystalline titanium carbide of sub-micrometer grain size without noticeable inclusions. Between the coating and the base metal is an intermediate layer of η-phase (Co_3W_3C). The hard alloy is decarbidized close to contact with the intermediate layer. Thickness of the coating increases linearly with time in a range of 10-450 minutes up to 15-17 μm. Analysis of the kinetics of growth indicates that a nucleation process of 15-20 minutes duration is followed immediately by growth of the carbide layers. The intermediate layer of η-phase is formed as the alloy is heated in the hydrogen stream before precipitation of the TiC begins, and terminates with the nucleation process. Preferred grain orientation is observed in the TiC layer during growth, first with planes (200), and then (after 90 minutes) with planes (111) parallel to the surface of the hard alloy base. By this time, the thickness of the carbide layer has reached about 5 μm, which is optimum for wear resistance. The carbide lattice constant increases with growth of the layer, and a small jump is observed in the lattice constant at a thickness of 2.2-3.2 μm. The oxygen impurity decreases with increasing thickness of the layer from 2 percent to 0.75, the most noticeable change occurring in the same thickness interval. The residual stresses in titanium carbide also decrease with increasing thickness. Mechanical tests show that a TiC layer at least 3-4 μm thick is needed for good durability. Figures 5; references 15: 4 Russian, 1 Czech, 10 Western.
[186-6610]

UDC 621.762.5:621.763

HIGH-POROSITY PERMEABLE MATERIALS MADE OF METAL FIBERS. I. INVESTIGATION OF STRAIN EFFECTS AND THE QUALITY OF MECHANICAL CONTACTS IN FIBROUS MATERIALS DURING SINTERING

Kiev POROSHKOVAYA METALLURGIYA in Russian No 8 (121), Aug 80 pp 63-66 manuscript received after revision 14 Feb 80

KOSTORNOV, A.G., MOROZ, A.L. and FEDORCHENKO, I.M., Institute of Problems of Material Science, UkSSR Academy of Sciences

[Abstract] An investigation was made of the effect of fiber size, porosity and temperature on deformation of metal fiber materials during sintering, and an evaluation was made of the degree of completeness of contacts between fibers as a characteristic responsible for sintering quality and the properties of conductivity of the material. Specimens were made of copper fibers 20, 40 and 70 μm in diameter and nickel fibers 50 and 100 μm in diameter. Fiber length was 3 mm. The specimen were made by precipitation of the fibers from a glycerin suspension, pressing and sintering. Copper specimens with porosity of 30-90 percent were sintered at 700-1000°C and held for 2 hours in dry hydrogen. Nickel specimens with porosity of 30-80 percent were sintered in two schedules: at 900-1200°C with holding for 2 hours in dry hydrogen; with sintering at 1400°C and holding for 2 hours in vacuum. It was found that materials made of copper fibers undergo considerable deformational changes in sintering. Increased dimensions due to relaxation of residual stresses show up most strongly in the direction of pressing on the low-porosity specimens made of the coarsest wire. The specimens stop growing and start to shrink as the sintering temperature increases and the fibers become finer. All changes are less pronounced for nickel specimens. Nickel specimens shrink slightly during sintering in the low-porosity region, and at higher porosities they increase in size. Analysis shows that strong contacts between fibers can reduce the effects of residual stress relaxation. High-porosity materials of fine metal fibers that are sintered at 90 percent of the melting point are not appreciably deformed during the sintering process, and have optimum conductivity. Figures 4; references 5: all Russian.
[186-6610]

UDC 669.715+669.35:621.74

IMPROVING DUCTILITY OF ALUMINUM AND COPPER ALLOYS BY A GRANULATION METHOD

Kiev POROSHKOVAYA METALLURGIYA in Russian No 8 (212), Aug 80 pp 72-76 manuscript received 1 Mar 80

BADAYEV, V.G., ZENTSOV, A.I. and GRISHINA, N.P., State Scientific Research and Design Institute of Alloys and Processing of Nonferrous Metals

[Abstract] Previous research has shown that granulation techniques based on anomalous supersaturation of solid solutions can be used in a certain range of concentrations and cooling rates to produce an alloy structure that consists of a depleted

solid solution and finely dispersed phases of eutectic, peritectic or primary origin. This principle is applied to aluminum alloys doped with elements that have limited solubility in aluminum in the equilibrium state, and that form unsaturated solid solutions at cooling rates typical of granulation (copper, silicon and so on). Such alloys may also contain elements that are practically insoluble in aluminum at cooling rates of 10^3-10^4 deg/s (such as iron), but that form phases that crystallize in finely dispersed form in granulation. Intermediate products pressed and rolled from such granulated alloys have high strength and ductility, and can be improved by heat treatment. The technique is also applied to certain copper alloys such as brass. Figures 4; references 12: 9 Russian, 3 Western.
[186-6610]

UDC 621.762:661.55:669.018

INTERACTION OF TITANIUM NITRIDE IN COMPOSITES WITH Ni AND Ni-Mo

Kiev POROSHKOVAYA METALLURGIYA in Russian No 8 (212), Aug 80 pp 85-89 manuscript received 26 Feb 80

BONDAR', V.T., Institute of Problems of Material Science, UkSSR Academy of Sciences

[Abstract] The interaction of titanium nitride with nickel is studied for alloying of a nickel binder with molybdenum and partial replacement of TiN with titanium diboride. Specimens of TiN-Ti, TiN-Ni-Mo and $TiN-TiB_2-Ni-Mo$ compositions were made by sintering, hot pressing, and by separate sintering-pressing. All compositions have low compactability. In hot pressing they form closed rounded pores, while in separate pressing and sintering the pores coagulate into irregular shapes. The structure of the hot-pressed specimens is characterized by higher density and uniformity of pore distribution. Hot-pressed specimens of TiN-Ni-Mo have a structure consisting of grains of the nitride phase of titanium with microhardness of 2100 $\pm$ 110 kgf/mm^2, and cementing interlayers based on Ni-Mo solid solution with microhardness of 410 $\pm$ 60 kgf/mm^2. Increasing the hot-pressing temperature to 1900°C and sintering in hydrogen increases the number of large branching pores and produces additional phases with microhardness of 2930 $\pm$ 380 and 2160 $\pm$ 290 kgf/mm^2. The best proportion of the distribution, shape and dimensions of phases formed in hot-pressed $TiN-TiB_2-Ni-Mo$ specimens is attained with a content of 50 percent TiB_2 in TiN with microhardness of 2800 kgf/mm^2, and another phase formed by interaction of TiB_2 with the Ni-Mo melt. The microhardness of this latter phase increases with sintering temperature up to 1600°C and with increased content of TiB_2 in the composition, and amounts to 4200 and 5000 kgf/mm^2 at contents of 50 and 75 percent by mass of TiB_2 respectively. Figures 3; references 11: 10 Russian, 1 Western.
[186-6610]

UDC 621.762

INVESTIGATION OF THERMAL PROCESSES DURING HOT HYDROSTATIC PRESSING OF HEAT-RESISTANT NICKEL ALLOY POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 80 pp 14-18 manuscript received 1 Mar 80

STAROVOYTENKO, Ye.I., GARIBOV, G.S., KOSTYUKOV, V.I., KRATT, Ye.P. and MOLCHANOV, I.V., All-Union Institute of Light Alloys

[Abstract] Heating of the pressing block prior to hydrostatic pressing is described on the basis of which the corresponding technology was developed and the engineering method for calculating the pressing was determined. With this method direct measurements of temperature in the powder during block heating cause serious difficulties of which the main causes are the aggressive properties of the working medium and sustaining a vacuum at high temperatures (1200-1250°C). It was determined that the period of block heating consisted of two stages. In the first stage the block heating determines the boundary conditions of the process and in the second stage the temperature of the powder is equalized. Duration of the first stage amounts to 8.5--9 hours. As temperature rises the viscosity of the hydrostatic medium drops, mixing intensity grows and the temperature at the capsule surface is equalized. The temperature on the block surface increases then quite rapidly up to that of the furnace medium, which indicates achieving an intense heat exchange between the block and gas medium of the furnace despite the fact that a heat-resistant steel is used to cover the dome for the purpose of creating a non-oxidizing condition. Figures 5; references 4: 3 Russian, 1 Western.
[17-6368]

UDC 621.762.53:621.89

WEAR-RESISTANT BRONZE-BASE COMPOSITE PRODUCED BY ELECTRIC-DISCHARGE SINTERING

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 80 pp 6-8 manuscript received 29 Mar 80

RAYCHENKO, A.I., ZABOLOTNYY, L.V., RYABININA, O.N. and PUSHKAREV, V.V., Institute of Problems of Material Science, UkSSR Academy of Science

[Abstract] The possibility of using electric-discharge sintering (EDS) to make antifriction wear-resistant items such as the sliding bearings of cutter drill bits was studied. Sintering was done using a pulsing a.c. of 2000-6000 Hz passed through a previously extruded and compacted part under a pressure of 3-8 Mn/m^2 where the materials used were Br010 bronze, bronze-stellite and bronze-sormite. The tribometric characteristics and wear resistance were determined during friction without a lubricant at sliding rates of 0.75-6 m/sec and gradual loading at 0.1 MPa until the temperature and friction force were stabilized. Results of mechanical and tribometric tests showed that the bronze-stellite and bronze-sormite were 1.5-2 times stronger than Br010. When comparing Br010 and the control material (3KhV8F steel) it was noted that at sliding rates of 6m/sec the coefficient of friction

and total wear of the control material and the two stronger bronzes were less, while they had double the support capacity of BrO10. References 4: all Russian.
[17-6368]

UDC 621.762

INVESTIGATION OF THE PHYSICO-MECHANICAL PROPERTIES OF TITANIUM CARBIDE WITH ADDITIONS OF TITANIUM NITRIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 80 pp 35-38 manuscript received 11 Mar 80

ANDRIYEVSKIY, R.A., ALEKSEYEV, S.A., DZODZIYEV, G.T., DZNELADZE, A.Zh., TRAVUSHKIN, G.G., TURCHIN, V.N. and CHERTOVICH, A.F., Moscow Institute of Fine Chemical Technology imeni M.V. Lomonosov and the Chirchik Affiliate of the All-Union Scientific Research Institute of Hard Alloys

[Abstract] A study was made of the physico-mechanical properties of TiC with TiN additions and the development of microductility of this alloy. Samples were prepared by homogenizing, at 1700°C for 1.5 hours, finely ground powders of titanium carbide and nitride with subsequent grinding and sintering at 1500°C for 1.5 hours. The tested samples with approximately 4 percent TiN accounted for the high microductility and crack initiation strength. This was determined from physical and mechanical tests of nine batches of the TiC-TiN sintered alloy where the effects of the nickel and tungsten were ignored but probably should be taken into account as the alloy with 4 percent TiN had 1.9 percent Ni and 1.37 percent and W had the lowest density (4.8 g/cm^2). Although conclusions are made based on the results of the tests, these conclusions don't seem to be justified since the chemical composition of the different batches varied considerably with respect to the Ni,W and TiN content. References 8: 7 Russian, 1 Western.
[17-6368]

UDC 669.618.45

INTERACTION OF BORON CARBIDE WITH TITANIUM UNDER CONDITIONS OF THERMAL AND PLASMA HEATING

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 80 pp 47-53 manuscript received 5 Feb 80

BORISOVA, A.L., BORISOV, Yu.S., SHVEDOVA, L.K., KOCHERZHINSKIY, Yu.A. and NECHIPORENKO, V.I., Institute of Problems of Material Science, UkSSR Academy of Sciences and the Institute of Metal Physics, UkSSR Academy of Sciences

[Abstract] The interaction of B_4C with titanium was studied by methods of thermodynamic, differential-thermal and x-ray phase analysis and microhardness measurement for the purpose of developing optimum coating composition and selecting the technological parameters of spraying. Three mixtures ($Ti+B_4C$, $Ti+1/2B_4C$ and $Ti+1/3B_4C$) were studied by the differential-thermal analysis (DTA) method at 2200°C.

The third mixture, which produced TiB_2 and TiC, had the highest thermal effect--823.5 kcal/kg. It was noted that thermal effects, associated with melting of titanium (1670°C), were not observed on the DTA curves. The first exothermic peaks for the three compositions were at 1440, 1475 and 1490°C, respectively. Comparison of the analytic test results showed an active interaction in the Ti-B_4C system which starts at 1300°C, the reaction occurs in the solid phase and is accompanied by considerable liberation of heat which depends on the mixture composition, other conditions being equal. Howeve , since the reaction is accompanied by significant volume changes, the reactants are separated into interaction products and a solid zone of porosity and the reaction rate is sharply reduced. To obtain plasma coatings, mixture 3 was used and prepared by the following methods: 1) rolled into strip with subsequent grinding and separation of the required fraction; 2) rolled and pre-sintered with subsequent grinding and separation of the required fraction and sintering below the temperature of active interaction to obtain a coarse conglomerate which did not diminish the exothermic reaction; 3) plating the boron carbide particles with a finely dispersed titanium powder using a phenol binder on a stainless steel substrate. From x-ray phase analysis the plasma coatings in the first two cases contained three phases--$TiCl_{-x}$, TiB_2 and B_4C, although the quantity of boron carbide in the plasma coatings, judging by the intensity of the x-ray lines, was significantly higher than in the DTA samples and the coatings were relatively dense. In the third case the coating had a fine grain with a typical eutectic structure and contained only two phases--TiB_2 and TiC_{1-x}. The absence of TiC in the coating was probably caused by partial combustion of the carbon when the coatings were sprayed in air. Figures 6; references 9: 8 Russian, 1 Western.
[17-6368]

UDC 621.762.5

ELECTRICAL-DISCHARGE SINTERING OF AN ALUMINUM-CARBON FIBER COMPOSITE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 80 pp 39-41 manuscript received 1 Mar 80

RYABININA, O.N., TUCHINSKIY, L.I., VISHNYAKOV, L.R. and DRACHINSKIY, A.S., Orenburg Polytechnical Institute and the Institute of Problems of Material Science, UkSSR Academy of Sciences

[Abstract] Grade AD-1 aluminum foil or PA-4 powder with a particle size of 20-40 microns were combined with 7-micron-diameter carbon whiskers (1.65 g/cm^3 density and 32,000 kgf/mm^2 modulus of elasticity) to produce an Al-C composite by means of electrical-discharge sintering EDS). The composite contained 35-70 vol percent fiber. The EDS was done according to the following parameters: pre-pressing pressure varied from 12.5 to 50 kgf/mm^2, a.c. frequency--2750-6000 Hz, effective current density--200-400 A/cm^2 and treatment time--1--4 minutes. Sample quality and strength depend on the mode of EDS, where it was established that a 250-300 A/cm^2 current density was optimum. A decrease in the current density impairs sample quality because sample treatment time must be increased, which amplifies an undesirable interaction between matrix and reinforcing fiber. Increasing current

density also leads to melting of the aluminum and its being squeezed in the mold gaps. A short treatment time does not provide a strong bond between fiber and matrix but an increase in the pre-molding pressure leads to increased sample strength. An a.c. frequency of 2750 Hz provided the best results. Thus, improved properties of Al-C composites can be achieved by means of using stronger fibers, applying coatings on them, improving the conditions of pore penetration and optimizing the technological mode of EDS. Figures 1; references 8: 6 Russian, 2 Western.
[17-6368]

UDC 621.762.5:621.763:669.24

FEATURES OF THE PROCESS OF SINTERING NICKEL FIBERS EXTRUDED FROM VISCOSE-BASE SUSPENSIONS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 80 pp 28-32 manuscript received 4 Jan 80

FEDORCHENKO, I.M., KOSTORNOV, A.G., KIRICHENKO, O.V. and PEREPELKIN, A.V. Institute of Problems of Material Science, UkSSR Academy of Sciences

[Abstract] A study was made of the process of sintering nickel fibers, extruded from powders, as well as the factors influencing this process. Viscose whiskers with diameters of 74, 38 and 26 microns were mixed with nickel powder which had a final diameter after sintering of 36, 22 and 10 microns. The initial fibers were heated in hydrogen at 200-1250°C for 1 hour and their structure studied. The process of sintering fibers produced in the above manner is characterized by volume changes of varying intensity in the following temperature intervals: at 200-400°C the fibers are compacted under capillary forces which are created by the escaping of liquid fractions in the process of polymer binder thermal destruction; at 400-800°C the shrinkage magnitude is independent of temperature owing to stability of the carbon-metal skeleton in the hydrogen. Local agglomeration of particles at 600-800°C has virtually no effect on fiber volume changes in view of the discreteness of this process; at 800-1200°C the metallic phase is sintered by the mechanism of diffusion-viscous flow. The characteristic temperature regions of polymer binder removal correspond to the characteristic temperature regions of fiber compaction for fibers extruded from nickel powders in a viscose base, which testifies to the interrelationship between both processes. Figures 3; references 7: all Russian.
[190-6368]

UDC 621.762.2

ON THE PRODUCTION OF MULTICOMPONENT METALLIC POWDERS WITH A PRESCRIBED COMPOSITION, STRUCTURE AND PROPERTIES

Moscow IZVESTIYA AKADEMII NAUK SSSR; METALLY in Russian No 5, 1980 pp 191-197
manuscript received 6 Aug 79

KARONIK, V.V., Moscow

[Abstract] A demonstration is given of the role of the structural state of three-component alloys based on magnesium and of the value of information on the structure of the state diagrams of the parent alloys in the problem of developing metal powders with a specific composition by employing subtractive metallurgy. In subtractive metallurgy n-component alloys are produced from alloys consisting of n+1 or a greater number of components, whereby the superfluous components are removed from the parent alloys by treating these alloys in a chemically active medium. Hitherto appropriate attention has not been devoted to a detailed study of the role of the relationship between the composition and structure of the parent alloys and the composition and structure of the materials produced by removing one of the components from the parent alloys. Here it is suggested that this problem can be solved on the basis of the ideas of geometrical thermodynamics expressed in the form of state diagrams. Aspects are discussed of the formation of a wide range of metallic powders based on silver, nickel, copper and palladium produced by using alloys of the following three-component systems: Mg-Ag-In, Mg-Ag-Cd, Mg-Ag-Cu, Mg-Ag-Sn, Mg-Ag-Zn, Mg-Ag-Li, Mg-Ag-Al, Mg-Ag-Pb, Mg-Ag-Si, Mg-Ag-Ge, Mg-Ni-Pd, Mg-Ni-La and Mg-Ni-Zn. Magnesium is the component to be removed and this operation is performed comparatively easily by treating the ternary alloys with acetic acid. The state diagrams for these systems are divided into two groups, the first of which is characterized by the presence of a relatively large area of the existence of a three-component solid solution based on magnesium, and the structure of the state diagram of the second group of alloys is distinguished by the fact that a region of a solid solution based on magnesium is practically absent. On the basis of data on the structure of the state diagrams of three-component systems the rules are discussed for the formation of two-component metallic powders, concentrating on the influence on the composition and structure of these powders of the structural state of the parent alloys, the peculiarities of the structure of the phase regions of state diagrams and the position in them of configurational points of the parent alloys and those produced. The powders are discussed in terms of chemical composition and phase composition. It is demonstrated that the approach outlined here makes it possible to control the chemical and phase composition of multicomponent powders. A study of individual state diagrams is necessitated by the decisive role of the structural state of alloys in the process of the creation of powders with a prescribed composition, structure and properties. Figures 4; re[illegible]s 4: 3 Russian, 1 Western.
[10-8831]

UDC 621.785.532:669.14.018.298.3

NITRIDING OF STEEL UNDER VACUUM

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 9, 1980
pp 13-15

LAKHTIN, Yu.M., KOGAN, Ya.D. and SOSHKIN, S.M., Moscow Automobile Road Institute and Moscow Automobile Plant imeni I.A. Likhachev

[Abstract] A demonstration is given of the feasibility of altering the structure of the diffusion layer in the process of nitriding at reduced pressure of an ammonia atmosphere. Armco iron and 40Kh, 38KhMYuA and 5 KhNM steels were used in the study. The steels were tempered to HRC 30-33 before nitriding, and which was done at 520 and 570°C for 1,2 and 4 hours at pressures of 100 to 760 mm Hg. After nitriding, the samples were cooled together with the chamber of the muffle furnace. Optimal utilization characteristics of the diffusion layer were arrived at by means of regulation of the nitrogen potential of the atmosphere through a change in pressure in the chamber. The optimal flowrate of ammonia was 7 to 9 liters/hr, which is ten times lower than with standard nitriding. Optimality here refers to the quality of the nitrided layer in terms of the depth of the diffusion layer and the lack of mottling on the surface of the sample. Metallographic analysis of the diffusion layer revealed three pressure ranges in which different structures of the nitrided layer are observed: 1) 760 to 200 mm Hg--$\varepsilon \to \gamma' \to N[Fe_\alpha]$; 2) 200 to 150 mm Hg--$\gamma' \to N[Fe_\alpha]$; and 3) 150 to 100 mm Hg--$N[FE_\alpha]$. An x-ray phase analysis employing a DRON-1 diffractometer with unfiltered chromium radiation showed that it is possible to produce the required structure and phase composition of the diffusion layer by nitriding steel under vacuum. For example, at pressures of 760 to 400 mm Hg for steel considerable intensification of the growth of the nitride zone was observed. The ε, γ' and α phases are contained in the nitrided layer, and a further reduction of the atmosphere's pressure suppresses the formation of the ε phase and at pressures of 200 to 150 mm Hg the nitride zone consists only of the γ' phase. At pressures below 200 to 150 mm Hg there is no nitride zone on the surface and the diffusion layer consists only of nitrous Fe_α. When steel is nitrided at 300 to 400 mm Hg pores are either completely absent in the nitride layer or appear in slight quantities. Mechanical tests of the steel samples were made on an Instron unit. Optimal values of strength and ductility for 40Kh and 38KhMyuA steel were reached in samples nitrided at 150 mm Hg. In this case the diffusion layer is formed on the basis of a nitrous alpha solid solution. Tensile tests were performed to reveal the nature of fracture in various zones of nitrided samples. Inhomogeneity of the fracture surface is characteristic of nitrided samples. The results of fatigue tests demonstrate that, for 40Kh and 38KhMyuA steel, samples with a nitrided layer consisting only of a nitrous alpha solid solution have the highest fatigue limit. Figures 2; references 5: all Russian.
[9-8831]

UDC 621.791.09:669.295

INFLUENCE OF THERMAL STRAIGHTENING ON THE FATIGUE STRENGTH OF A TITANIUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, 1980 pp 54-57 manuscript received 12 Sep 79, after correction 24 Jan 80

GOLOVCHENKO, V.S. and MIKHAYLOV, V.S., doctors of technical sciences, and ZAIKIN, V.M., candidate of technical sciences, Leningrad

[Abstract] Investigations were made of the fatigue strength of welded joints of a titanium alloy of the Sp3 type for the purpose of determining the effectiveness of using various kinds of local heating in the thermal straightening process and of determining the influence of these methods on the capacity of welded structures for work. Test structures were made from an alloy with a yield stress of $66 \cdot 10^7$ N/m^2 and an ultimate strength of $73 \cdot 10^7$ N/m^2, and were assembled from sheets 10 mm thick and a cross frame whose elements were welded together and then to the sheets by means of manual argon arc welding. Shockless thermal straightening of welding deformations of the experimental structures was performed by using three methods of heating--by applying "dummy weld beads", by performing "dummy passes", and by using oxyacetylene torches. The results of the experiments demonstrated that the most economical is local heating with an oxyacetylene torch. This does not require the use of electric power nor of expensive argon, filler material and tungsten electrodes and eliminates the labor intensive operations of finishing areas after heating and of removing filler metal. The results of bending tests for fatigue performed on LKI NR-100 machines demonstrated that local heating reduced the fatigue limits of the alloy by 30 to 40 percent, but no substantial differences were discovered in the influence of the heating methods studied on the durability of the alloy. When necessary, all three methods of local heating can be employed for thermal shockless straightening of sheet metal structures made from titanium alloy Sp3, but local heating with oxyacetylene torch is the most economical. Figures 6; references 5: all Russian.
[8-8831]

UDC 669.295:621.771.014.2:669.2/.8

LUBRICANT FOR HOT PRESSURE SHAPING OF TITANIUM ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR; METALLY in Russian No 5, 1980 pp 97-98
manuscript received 24 Dec 78

GOTLIB, B.M., Sverdlovsk

[Abstract] Glass enamels are used as lubricants in the hot pressure shaping of titanium alloys and they also partially prevent the surface layers of the metal from cooling and the resulting reduction in ductility and formation of surface cracks. The effectiveness of preventing the surface from cooling too quickly can be improved by adding to the glass enamel lubricant an exothermic additive consisting of an aluminum powder and iron scale. The components of the lubricant are then in the following proportion in percentage by weight: aluminum powder 4 to 6, iron scale 15 to 25 and glass enamel the remainder. The additional heat of the exothermic reaction released in the process of hot shaping prevents the surface layers of the metal from cooling and keeps the lubricant heated, thus enabling even coating of the surface of the item being shaped with the lubricant and improving the lubricant's antifriction properties. A description is given of an experiment conducted to test a lubricant of this sort when applied to titanium alloys undergoing hot pressure shaping. The iron scale was crushed to a grain size of 0.1 mm and it was mixed together with aluminum powder and EVT-24 glass enamel in a ball mill. The mixture was applied to a sheet of paper which had first been wetted with water glass. The thickness of the powder layer equaled 4 to 5 mm. Then a second sheet of paper also wetted with water glass was placed on top. The edges of the bottom sheet were folded and cemented to the top sheet. The lubricant was then dried at room temperature for 5- to 6 hours, after which it proved to be sufficiently strong. When the paper envelope containing the lubricant contacts the hot billet the paper burns away and the exothermic additive begins to react with the intense release of heat. The experiments demonstrated that the lubricant is removed easily from the surface of the item and from the shaping tool after the shaping operation. There is a total absence of cracks on the surface of rolled strips even with 40 percent reduction. The modified lubricant suggested here is best used in hot forging thin-sheet articles made of titanium alloys at a temperature of the stock being forged of from 700 to 1000°C. Figures 1; references 1: all Russian.
[10-8831]

UDC 621.787:669.295.5

EFFECT OF PLASTIC SURFACE DEFORMATION ON THE SURFACE QUALITY AND THE FATIGUE STRENGTH OF AN α-PHASE TITANIUM ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 8, Aug 80 pp 109-111, 118 manuscript received 29 Jan 79

BAVEL'SKIY, D.M., IVANOV, A.V., GOLUBEV, Yu.G. and MEZHONOV, V.A., Planning Department, "Nevskiy Zavod" imeni V.I. Lenin, Leningrad and Kuybyshev

[Abstract] A study was made to determine the effect of hardening by plastic surface deformation on the surface layer and the fatigue strength of an α-phase titanium alloy. Flat cantilever specimens of PT-3V titanium alloy were treated by shot blasting with 2-mm steel balls in a stream of transformer oil. Both the oil pressure and the treatment time were varied, the surface roughness was measured under a dual microscope as well as with an interferometer, and fatigue tests on a 10^7 cycles basis were performed in a Shinken G-0190 electrodynamic vibration stand at room temperature. The fatigue strength was increased from 11 to 30 kgf/mm^2 by blasting in two stages: first under a gage pressure of 2 atm for 8 min and then under a gage pressure of 1 atm for 8 min, no further improvement resulting from treatment at higher pressures for the same length of time. According to an x-ray microstructural examination, the thus formed 220--280-μm-thick surface layer had not only a sufficiently high dislocation density but also the just optimum level and distribution of crack inhibiting residual compressive stresses. Subsequent holding of thus hardened specimens at high temperatures for long periods of time was found to cause stress relaxation, complete at 400°C, without loss of fatigue strength till 500°C and then recrystallization at 600°C with a corresponding fast decrease of fatigue strength. Figures 4; references 6: all Russian.
[189-2415]

UDC 669.295

INTERACTION OF ATMOSPHERIC MOISTURE WITH TITANIUM SPONGE

Moscow TSVETNYYE METALLY in Russian No 9, Sep 80 pp 58-63

LISKOVICH, V.A., IVASHCHENKO, V.I., ULIZ'KO, Ye.S. and GONCHAR, A.S.

[Abstract] Moisture has a detrimental effect on titanium sponge with prolonged exposure. In this paper the authors study the effect of chlorine on moisture absorption by titanium sponge, and determine the effect of moisture on sponge strength. An estimate is made of the reserves of the Kroll process for reducing the detrimental effect of humidity on the quality of titanium sponge. The experiments were done in a weather chamber with various relative humidities. It was found that storage of titanium sponge in contact with air results in absorption of moisture with a concomitant increase in oxygen content by 20-30 percent and increased hardness. It was found that the rate of moisture absorption depends on chlorine content: the higher the chlorine content, the more prolonged will be the saturation process. Under conditions of reduced humidity, an increase in chlorine content in titanium sponge has no negative effect on quality, which enables intensification of the reduction process. The moisturized sponge contains compounds of the type $xMgCl_2yMgOzH_2O$ and also titanium oxychlorides, which are a source of oxygen in the metal. Figures 4; references 15: 14 Russian, 1 Western.
[7-6610]

UDC 669.295.5:539.56:669.788

EFFECT OF HYDROGEN ON THE NOTCH AND CRACK SENSITIVITY OF OT4 TITANIUM ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 80 pp 29-32 manuscript received 28 Dec 78

KOLACHEV, B.A., BUKHANOVA, A.A. and SEDOV, V.I., Moscow Aviation Technology Institute

[Abstract] The effect of hydrogen on the strength properties and critical coefficient of stress intensity (K_c) was studied for sheet, rod and strip made of OT4 titanium alloy using different types of notches. The strength of samples containing 0.03 percent hydrogen is less than the strength of vacuum samples with a notch radius less than 0.13 mm. Impact strength, with an increased content of hydrogen in the sample, is most sharply diminished for a notch radius of 0.5 mm. In tests with circular samples K_c is lowered with increased hydrogen content more drastically than with flat samples. With increased loading time K_c is lowered, tending toward a low threshold value. The most sensitive methods of evaluating metals for their tendency to hydrogen embrittlement of the first nature is impact testing of samples with a notch radius of 0.5 mm and failure ductility. Figures 4; references 5: 4 Russian, 1 Western.
[2-6368]

UDC 669.265.5:(621.9.015+621.787)

DEPENDENCE OF THE CYCLE LIFE OF VT6 TITANIUM ALLOY ON THE SURFACE ROUGHNESS AND EFFECTIVENESS OF HARDENING THIS ALLOY BY PLASTIC SURFACE DEFORMATION

Kiev PROBLEMY PROCHNOSTI in Russian No 8, Aug 80 pp 31-34 manuscript received 11 Sep 79

BRONDZ, L.D., Moscow

[Abstract] A study of VT6 titanium alloy and 30KhGSN2A high-strength steel was made to compare the dependence of their low-cycle life on the surface roughness, controlled by machining of the specimens, and to determine the effectiveness of subsequent hardening of the VT6 titanium alloy by plastic surface deformation. The life tests were performed under cyclic loads, first in pure flexure with a stress amplitude of 75 kgf/mm^2 and then in tension with a stress amplitude of 80 kgf/mm^2. The life of VT6 specimens in the low-cycle range was found not to depend as strongly on the surface roughness as that of 30KhGSN2A specimens, but also to generally decrease with increasing surface roughness as measured on profilograms. Hardening of VT6 specimens by three different methods of plastic surface deformation has revealed that the life of specimens with an initially rougher surface is lengthened most effectively by shot peening, that the life of specimens with an initially smoother surface is lengthened most effectively by vibration shot shaking, and that air-pressure blasting is least effective regardless of the initial surface roughness. Figures 3; references 2: both Russian.
[189-2415]

UDC 621.791.(72+75).052:620.18

COMPARISON OF LASER AND ARC WELDING PROCESSES

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 9, Sep 80 pp 1-3

GRIGOR'YANTS, A.G., doctor of technical sciences, KOSYREV, F.K., engineer, FEDOROV, V.G., IVANOV, V.V. and MORYASHCHEV, S.F., candidates of technical sciences, and IVANOV, Yu.N. and FROMM, V.A., engineers

[Abstract] Comparative experiments were conducted into laser and argon-arc welding processes using different materials: low-carbon (St3 and St10) and stainless (Kh18N10T) steels, high strength alloys (30KhGSA, 18 Kh2N3MDA, 28Kh3SNMVFA and 10Kh16N4B) and titanium alloys (VT7 and VT28). Thickness of the materials amounted to $(1.5\text{-}4.5)\cdot 10^{-3}$ meters. It was found that the effective and thermal emfs of laser welding were 0.35-0.65 and 0.38-9.42, respectively. Laser weld joints were protected by blowing the high-temperature region and heat-affected zone with a flow of inert gas (argon or helium or a mixture of the two in different proportions) through a special nozzle through which the laser beam passed. Argon-arc welding protective effectiveness was better than for laser welding whereupon the gas consumption per one meter of seam was reduced by 1/8-1/5 in laser welding. Laser welding of the high-strength alloys in comparison with arc welding provided an increased resistance to slow failure over the entire range of welding speeds. It was established that laser welding lowers the residual longitudinal strains by 1/5 - 1/3 and residual lateral strain by 1/6 - 1/5 and the peak value of longitudinal residual stresses were not increased in comparison with arc welding. The maximum values of compressive stresses in the base metal after laser welding decrease by 40-70 percent, which makes it possible to avoid losses in weld joint stability and eliminate any subsequent operations of finished part straightening. Figures 8; references 6: all Russian.
[13-6368]

UDC 621.791.754'293

INVESTIGATION OF THE SPECTRUM OF THE ARC PLASMA IN ARGON ARC WELDING OF TITANIUM WITH A TUNGSTEN ELECTRODE IN RELATION TO THE FLUX

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, 1980 pp 23-25 manuscript received 13 Nov 79, after correction 4 Mar 80

YEROSHENKO, L.Ye., engineer, ZAMKOV, V.N. and MECHEV, V.S., candidates of technical sciences, and PRILUTSKIY, V.P., engineer, Institute of Electric Welding imeni Ye.O Paton, UkSSR Academy of Sciences

[Abstract] An experimental investigation was made of the reasons for contraction of the arc by means of fluorides, of features of the dissociation of fluoride vapors, and of the distribution of products of dissociation in the arc gap in the process of argon arc welding of titanium with a flux and a tungsten electrode. The purpose of the investigation was to select optimal compositions of fluxes and to improve the welding technology. A determination was made of the composition of the arc plasma by spectrographing the arc when welding VT1-0 technical titanium 8 mm thick. Welding was performed with a forward current of 100 A in first-quality argon with a welding rate of 8 m/hr and an adjusted arc length of 5 mm, using an SVI-1 tungsten electrode 3 mm in diameter with a 30° tip. The spectrum of the arc plasma was studied when welding with a layer of fluorides of lithium, aluminum, socium, calcium, barium and magnesium, representing the key components of welding fluxes for titanium. The products of the dissociation and ionization of these fluorides observed in the arc's plasma were studied. They include: LiI; NaI, TiF; CaI, CaII, CaF; BaI, BaII; MgI, MgII, MgF, TiF; AlI, AlII, AlF and TiF; for LiF, NaF, CaF_2, BaF_2, MgF_2 and AlF_3, respectively. Lines of excited atoms and ions and molecular bands of the products of dissociation of the flux and of its interaction with the titanium were observed in the spectra of arcs along their periphery. Fluorine lines were not observed in the spectra of arcs when welding titanium. The effectiveness of a flux, i.e., its ability to increase the intensity of fusion, depends on the concentration of TiF_2 and TiF_3 in the arc gap: the higher the concentration, the more effective the flux. Figures 3; references 4: all Russian.
[8-8831]

UDC 621.791.72

DYNAMICS OF CHANNEL FORMATION UNDER CONDITIONS OF ELECTRON BEAM WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, 1980 pp 26-27 manuscript received 6 Feb 80, after correction 11 Apr 80

MITKEVICH, Ye.A., candidate of technical sciences, Leningrad Polytechnical Institute, and LOKSHIN, V.Ye., candidate of technical sciences, Institute of Electric Welding imeni Ye.O. Paton, UkSSR Academy of Sciences

[Abstract] A description is given of an experiment performed to study the dynamics of channel formation in electron beam welding. The model employed consisted of a butt-jointed slab of metal and of quartz glass. The beam was moved along the joint so that it acted only on the metal and so that the majority of the metal flowed along the metal wall of the channel formed between the metal and the glass. The process was viewed through the quartz glass and photographed with a high-speed motion picture camera. By studying the radiation of the open channel it was possible to estimate the temperature of its surface and the energy transmitted from the beam by elements of the surface. The motion picture camera used light filters PS-13, FS-7 and SZS-22 for AMg6 alloy. A study of the motion picture frames revealed the following. The region of maximum release of the beam's energy and, consequently, of maximum heating of the metal, moves continuously along the interior of the channel and lies at the front of the beam's interaction with the metal. The temperature is maximal at this front. The rate of movement of the beam into the interior of the channel is reduced with an increase in its depth and depends on the

focusing level. After the electron beam forms a channel of maximum depth, the region of maximum heating begins to rise toward the top. If the absence of a beam on the floor of the channel or a sudden reduction in its intensity are of sufficiently short duration then the channel is not necessarily filled with molten metal. It is considered highly probable that the power density of the beam changes as a result of its scattering in vapors of the metal. The molten surface of the channel shows an influence on the distribution of energy over its cross section. The electron stream is reflected from the surface of the channel lying in the area of exposure, which is evidenced by the fact that in individual instances the region of the release of energy lies outside the zone of influence of the electron beam. The beam periodically influences various elements of the channel's cross section and heats these elements to different temperatures. The redistribution of energy takes place inside the channel because of the intense reflection and scattering of the beam when it acts on the channel's surface. Figures 2; references 3: 1 Russian, 2 Western.
[8-8831]

UDC 621.791.763.1

STRENGTH AND QUALITY CONTROL OF WELD JOINTS MADE FROM ALUMINUM-BORON COMPOSITES

Kiev AVTOMATICHESKAYA SVARKA in Russian No 6, Jun 80 pp 20-23 manuscript received by 26 Jun 79

RYAZANTSEV, V.I., candidate of technical sciences, FEDOSEYEV, V.A., engineer, and SHAVYRIN, V.N., candidate of technical sciences, Moscow

[Abstract] A study was made of the mechanical properties of weld joints made using a VKA-1 unidirectional fiber composite of the Al-B system with 35 and 50 percent B. Weld joints using VKA-1 and aluminum alloy D16T were also studied. Sample thicknesses being joined were 1 + 1 mm, 1.5 + 1.5 mm and 2.0 + 2.0 mm. The shearing force required to separate the joined materials was greatest for the VKA-1+D16T pair and, for all the joints of the VKA-1+VkA=1 and VKA-1+D16T composites, the shearing force was stronger when the fibers ran in the longitudinal direction and the boron content was 35 percent. The increased fatigue strength of samples with 35 percent B was explained by the fact that the strength of joints made by spot welding depends on the rigidity of the joint during cyclic tests and the VKA-1+D16T pair had a higher rigidity and a considerably smaller bend angle under the action of a load. In the case of the combination pair, rupture always occurred in the element of the D16T joint at some distance from the edge of the spot. This phenomenon was never observed during fatigue tests of D16T, AMg6, 10420 and V95 alloys. Figures 3; references 8: 6 Russian, 2 Western.
[191-6368]

UDC 621.791.052:539.4.014

RELAXATION OF STRESSES DURING HEAT TREATMENT OF TITANIUM ALLOY WELD JOINTS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 8, Aug 80 pp 8-10

POVAROV, I.A., engineer, and GLAZUNOV, S.G., doctor of technical sciences

[Abstract] The method and equipment have been developed for relaxation tests of titanium alloy weld joints using zone-induction and furnace annealing. In contrast to creep, during relaxation the strengthening from plastic deformation is not great and has little effect on the intensity of the relaxation process. Relaxation tests for VT22 alloy at 700°C showed that a large part of the stresses (55-73 percent) can be removed even in the heating stage and in the step of unsteady-state relaxation during brief zone-induction annealing. The heating rate up to the annealing temperature substantially influences the level of retained stresses in the metal. During rapid heating (4°C/sec) the retained stresses amount to 45 percent but at a rate of 1°C/sec--only 27 percent. For VT5-1, VT20, VT6S and VT6 alloys there is a sharp lowering of residual stresses in the heat-affected zone which starts at 600°C. However, weld joints of VT20 alloy, containing 1 percent Mo, 1 percent V and 2 percent Zr, are not chemically strengthened in the crystal lattice but have noticeably increased creep resistance up to 500-600°C and maintain a high level of relaxation stability (51 percent) at 650°C when soaked for 30 minutes. Total removal of residual stresses in these four alloys can be done by heating to 800-850°C. By decreasing the Al content to 1.5-3.5 percent and adding 1.5 percent Mn to OT4-1 and OT4 alloys the relaxation process becomes quite intense in the weld joints even at 500-550°C (32 percent for OT4-1 and 42 percent for OT4). Complete removal of residual stresses in the weld joints of these alloys can be done by annealing at 650-700°C. By lowering Al content to 4--4.5 percent and compensating by adding 3 percent Mo to VT14 alloy and alloying VT23 alloy with 1 percent Cr and 0.5 percent Fe, creep resistance can be increased to provide relaxation stability up to 500-550°C. The new, high-strength beta-solid solution VT32 alloy with 65-80 percent beta-phase will contain 85-95 percent of this phase after a complete anneal with rapid cooling (5-8°C/sec). At annealing temperatures of 500-550°C and five minute soaks the magnitudes of relative residual stresses in VT22 and VT32 alloys are practically the same. However, for longer soaking periods, 30 to 120 minutes, the relaxation resistance of VT32 is much higher than for VT22. This difference is explained by the small diffusion mobility of atoms and the high stability of the beta-solid solution for VT32. Figures 3; references 3: all Russian.
[3-6368]

UDC 621.791.4:539.378.3

DIFFUSION WELDING OF FINNED PANELS MADE OF TITANIUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 7, Jul 80 pp 43-45 manuscript received 7 May 79, after final revision 5 Dec 79

MATYUSHKIN, B.A., candidate of technical sciences, KOTEL'NIKOV, A.A., candidate of technical sciences, and MAYDANOV, L.P., engineer, Moscow

[Abstract] Finned panels of titanium alloys are now produced by fusion welding, which requires laborious heat treatment for stress and strain relief as well as prevention of sponging and cold cracking. The feasibility of producing such panels by diffusion welding under compression (588 kN vertically, 294 kN laterally, 196 kN frontally) in vacuum ($6.65\cdot10^{-2}$ Pa) at 1000°C was, therefore, studied on specimens of four titanium alloys: VT6S, VT6Ch, VT20 and OT4. Forming fillets was found to be the most difficult problem, solved by decreasing the shrinkage of the fin metal to 1.5 mm maximum and simultaneously using a weld wire or ribbon of another metal (VT1-00 titanium alloy) with adequate plastic properties. Afterwards underwelds are removed with excess metal from the surface and the fillets are finished by chemical milling. Oxygen which has penetrated the surface layer during welding is subsequently removed by vacuum annealing at 800°C for 2 hours (VT20 alloy) or by purging with an HNO_3:HF:H_2O=0.7:0.2:1 solution. This method of welding becomes uneconomical for panel members thicker than 8 mm. The fatigue strength of such joints with 1.5--4-mm-thick members is much higher than that of joints produced without chemical milling of fillets and that of joint produced by arc welding. Figures 4; references 4: 3 Russian, 1 Western.
[189-2415]

METAL: WAYS TO ECONOMIZE

Moscow TRUD in Russian 25 Sep 80 p 2

[Article by Academician I. Glebov, board chairman of the Leningrad Oblast Council of the Scientific and Technical Society]

[Text] In our time there is no need to prove how important the role of the Scientific and Technical Society is in the development of science, engineering and production. In Leningrad there are about 300,000 members of the NTO [Scientific and Technical Society] and last year alone the implementation of proposals contained in their personal creative plans brought a cost benefit exceeding 132 million rubles.

The initiative of the Scientific and Technical Society of the Leningrad Production Association Elektrosila with respect to improving the technical level of products produced by the association plants and also available in the association and coming in from the new process equipment has become widespread in the enterprises of the country.

The oblast council of the Scientific and Technical Society has now set the goal of directing the creative activity of the members of the Scientific and Technical Society to the solution of large-scale complex programs having national economic significance. One such complex program is directed at solving the problems of the most efficient use and economy of metal in the light of the resolutions of the November (1979) Plenum of the Central Committee of the CPSU.

Unfortunately, in spite of the enormous quantity of metal produced in the country it does not suffice for the needs of our national economy. The process waste of metal on the whole throughout the country is more than 25%. This waste not only is not reduced, but, on the contrary, increases specially as a result of fractionation of the metal into shavings.

For the Scientific and Technical Society of Leningrad, the struggle for economy and sparing use of metal has become one of the most important problems. A complex scientific and technical program has been created which defines the most important areas of operation such as improvement of the metallurgical production process, the introduction of new advanced processes for machining metal at the machine building enterprises, replacement of metal by plastics, and control of corrosion.

As a result, in four years of the five year plan the Leningrad workers have saved about 220,000 tons of ferrous metal and more than 120,000 tons of nonferrous metals.

In the concluding year of the tenth five year plan, the decision has been made to save another 63,000 tons of ferrous metals.

This savings is not so much the result of an economizing attitude toward material on the part of individual, most zealous workers, as the consequence of purposeful work with respect to improving the production technology, the introduction of new methods of machining metal. Let us say, at the Lentrudlit plant by the initiative of the organization of the Scientific and Technical Society for several years competitions have been held with respect to lowering the metal consumption of products. During the course of the competition a proposal came in for casting large-diameter pipe with minimum allowances. This made it possible to save 240,000 tons of metal in a year.

However, there are examples of another procedure. Thus, at the Plenary Session of the Leningrad oblast board of the Scientific and Technical Society of nonferrous metallurgy on the use of nonferrous metals it was noted that at a number of the metallurgical enterprises, a significant amount of expensive nonferrous metals was being dumped into the tailings with the slag. Indeed, in scientific and engineering-technical respects the problem of extracting deficit metals in slags has been solved. The required developments exist for slag and certain other waste of the metallurgical industry to be included in the valuable raw material nomenclature. This solution would give the country many thousands of tons more metal. However, in spite of the obvious expediency of the proposals of the Scientific and Technical Society, the planning agencies are not including the use of slags in the state plans.

Every year more than 2 million tons of metal scrap are dumped in the tailings piles along with the steel-making slags. The oblast board of the Scientific and Technical Society has noted specific measures so that the slag processing idea will not hang in the air but begin to be implemented. However, in order that the use of the waste be put on the industrial tracks, serious attention is needed to this problem on the part of the USSR Gosplan, the USSR Ministry of Ferrous Metallurgy, and the USSR GKNT.

Enormous gains have come to the national economy from t[illegible] application of powder metallurgy. By the initiative of the oblast committee [illegible] he party, the Leningrad oblast board of the Scientific and Technical Society o[illegible] [illegible]errous Metallurgy and the Scientific and Technical Society of the Machine Building Industry jointly with the Council of Economic and Social Development under the Leningrad Oblast Committee of the CPSU have called a scientific and technical conference devoted to generalization of the experience of the introduction of powder materials into industry. Their introduction is a valid, effective and already tested method of saving metal. However, powder technology is still used in a very limited scale.

Practice shows that the central problem of the broad introduction of powder metallurgy technology into machine building must be considered to be primarily the organization of highly economical production of high-quality powdered iron and alloys based on iron. In Leningrad there is still much to be desired with regard to the powdered metallurgy base. This amounts to only specialized production at the "Instrument" [tool] plant in several low-capacity sections in the "Istochnik" association. By recommendation of the Scientific and Technical Society of Leningrad it is proposed that the rebuilding of the "Instrument" plant be included in the 11th five year plan in order to organize the production of 210,000 tons of powder products per year here. Provision has also been made for the creation of new and the

expansion of existing sections for the production of products made of powdered metals. It also appears entirely possible and expedient to us to organize the production of compositional powders at the "Severonikel'" combine in the interests of the enterprises of the northwestern region and granulated aluminum at the enterprises of the Leningrad Vtortsvetmet. It appears no less important and realistic to organize low-tonnage production of high-quality powdered iron at the experimental base of the "Mekhanobr" Institute. In essence everything that is needed is available here.

The situation is unsatisfactory with regard to the equipment for powdered metallurgy. The failure to provide production with presses, the absence of furnace and other specialized equipment involves the manufacture of "homemade" equipment, and this increases the cost of the powder product and has a negative effect on its quality. The USSR Gosplan and the corresponding USSR Ministry must, as it appears to us, give more attention to these problems in the new five-year plan.

Unfortunately, it is impossible not to note the strange attitude of certain branch institutes and design offices toward the solution of this problem. Their position to a defined degree reflects the planning deficiencies on the lack of attention of such organizations as the USSR Ministry of Nonferrous Metallurgy and other ministries and departments toward regional needs. It is good, for example, that the specialists of these organizations, being in Leningrad, introduce powder metallurgy in the Urals, in Siberia, but is understandable why they do not do this at the Leningrad branch plants, although they are much in need of it. These problems of the application of powder metallurgy are being resolved at the "Kirov plant" by the branch institute located in the Urals. It is considered that it is also necessary to bring order into this matter.

The necessity of the fastest propagation of powder metallurgy is indicated by the fact that the manufacture of parts by this method permits the expenditure of three to five times less metal. With all the expediency of powder metallurgy it is only taking the first modest steps. The primary cause of the slow development is that the new method has no master.

At the present time all of these problems are being dealt with by the scientific council of the USSR Academy of Sciences in the problems of powder metallurgy and composition of materials organized in Leningrad with the active participation of the members of the scientific and technical society. The council has made specific proposals which will promote an effective implementation of powder metallurgy.

These proposals have been transmitted to the planning agencies. We hope that they will find reflection in the draft of the new five-year plan.

Another area of our work is control of corrosion and the protection of metals. According to the estimates of the specialists, the total annual losses from corrosion in our country amount to 40 billion rubles. About 14 million tons of metal are scrapped prematurely. The concern for the maintenance of the metal stock has become one of the central problems of the interbranch committee of the Leningrad oblast council of the Scientific and Technical Society for corrosion control. At the present time this committee is giving a great deal of attention to the broad introduction into practice of organosilicate materials developed by the Institute of the Chemistry of Silicates of the USSR Academy of Sciences. Experience is proving the high reliability and effectiveness of these coatings. For example, the

Lenmostotrest Trust uses organosilicon coatings to prevent atmospheric corrosion of steel and reinforced concrete bridge structures, tunnels and enclosures.

The analysis of the letters of a hundred different enterprises and organizations of the country demonstrated that the demand for organosilicon materials by 1990 will be tens of thousands of tons. As is said, the time has come for this problem. It awaits urgent solution. In the near future, according to the calculations of the specialists, it is necessary to develop the production of new prospective materials to several thousands of tons per year. The institute of the Chemistry of Silicates of the USSR Academy of Sciences considers it necessary to create an experimental-industrial base for the processing and introduction of the advanced technology of obtaining them and their production in small lots. This is one of the important problems of the eleventh five-year plan, and we relate its solution to the forthcoming 26th Congress of the CPSU. The effective work in the various areas will permit the Leningrad workers to make a new contribution to the strengthening of the material and technical base of the country.

[19-10845]

10845
CSO: 1842

UDC 621.375.91

A LOW-ENERGY HIGH-DENSITY PULSED ELECTRON BEAM FOR SURFACE HEATING

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 253, No 6, 1980 pp 1383-1386
manuscript received 29 May 80

MESYATS, G.A., corresponding member, USSR Academy of Sciences, PROSKUROVSKIY, D.I. ROTSHTEYN, V.P. and LEBEDEVA, N.I., Institute of Large-Current Electronics, Siberian Department of the USSR Academy of Sciences, Tomsk

[Abstract] High-power nanosecond electron beams are used for surface heating of metals and semiconductors. Where fast heating and subsequent cooling of the surface layer not thicker than 10^{-4} cm is required such a beam should feature a high-density current (1--3 kA/cm^2) of low-energy electrons (10-20 keV), which is attainable with explosively emitting cathodes. Here the design and the performance of a diode with such a cathode are analyzed in terms of pulse power-time and surface temperature-time characteristics. The practical application is demonstrated on the examples of a 15 keV electron beam with a pulse duration of 20 ns and a maximum power density of 25 MW/cm^2 heating vacuum-annealed copper, causing plastic flow in the surface layer in the process, and an electron beam with a pulse duration of 50 ns and a maximum power density of 20MW/cm^2 annealing silicon which has been doped by implantation of 150 keV phosphorus or arsenic ions $6 \cdot 10^{13}$-$6 \cdot 10^{15}$ cm^{-2}. In this case such a treatment facilitates recrystallization of the amorphized surface layer and improves the electrical characteristics of the thin p-n junction. The authors thank L.S. BUSHNEV for helpful suggestions, and B.S. AZIKOV and N.G. MOISEYEV for preparing the doped silicon specimens. Figures 2; references 7: 5 Russian, 2 Western.
[187-2415]

UDC 661.666.2

PROTECTION OF CARBON MATERIALS BY HIGH-MELTING COMPOUNDS

Moscow TSVETNYYE METALLY in Russian No 9, Sep 80 pp 54-58

DERGUNOVA, V.S.

[Abstract] A brief survey is made of techniques for increasing the strength of carbon materials and applying protective surface coatings. Volumetric strengthening of graphite materials has been done basically in two ways: impregnation from melts of various high-melting metals and alloys, and adding powders of high-melting compounds to a carbon charge with subsequent hot pressing or sintering. Coatings

are applied by plasma sputtering, argon-arc surfacing and deposition from the gas phase. Research is now being done on protection of carbon materials by whiskerizing and by metallizing fibers at low temperatures. Investigations of interaction on the interface has shown that diffusion is mainly from the carbon material into the protective high-melting compound. Interaction produces solid solutions of carbon in the metal, followed by carbide interstitial phases. Most high-melting borides do not dissolve appreciable amounts of graphite, although carboborides are sometimes formed at very high temperatures. Silicides are less stable than carbides, nitrides or borides, and begin to react at lower temperatures. Oxides form gaseous reaction products with carbon, resulting in rapid formation of a carbide layer on the contact interface. Volumetrically strengthened carbon materials have higher heat resistance and are stronger when heated than coated materials. References 21: all Russian. [7-6610]

UDC 621.9.047.7

ANODIC BEHAVIOR OF MOLYBDENUM-RHENIUM ALLOYS

Moscow ZASHCHITA METALLOV in Russian Vol 16, No 5, Sep-Oct 80 pp 581-583 manuscript received 24 Jul 78, after revision 20 Sep 79

AMIRKHANOVA, N.A., TATARINOVA, O.M. and RAFIKOVA, L.G., Ufa Aviation Institute

[Abstract] Molybdenum is an increasingly used refractory material that shows improved strength and ductility when alloyed with rhenium. In this paper a study was made of the anodic behavior of molybdenum-rhenium alloys as a function of composition with respect to electrochemical machining, which is the most promising way to handle these materials. Molybdenum alloys were vacuum melted with 20, 40, 60 and 80 percent rhenium. Analysis of the Mo-Re phase diagrams of these alloys showed that the first two compositions are α-phase, the third is $\alpha+\sigma$ phase, and the fourth is σ-phase. The concentration of components and state of the surface layer were determined before and after polarization. Anodic enrichment of the surface layer with molybdenum and depletion of rhenium were observed for the α -alloys within a range of 3.5-4.0 percent, and for the $\alpha + \sigma$ alloy--up to 9 percent with respect to molybdenum. The alloy with 60 percent rhenium showed partial erosion of the σ-phase. Other than in the surface layer, uniform dissolution of the components was observed on the whole at high current densities. Figures 1; references 8: all Russian
[5-6610]

UDC 621.198

STRUCTURE OF PHASE ANODIC ALUMINUM OXIDE FORMED IN SULFAMIC ACID SOLUTIONS

Moscow ZASHCHITA METALLOV in Russian Vol 16, No 5, Sep-Oct 80 pp 576-578 manuscript received 10 Jul 79, after revision 27 Oct 79

BOGOYAVLENSKIY, A.F., and VOYEVODINA, N.M., Kazan' Aviation Institute

[Abstract] In a previous paper [see ZHURNAL PRIKLADNOY KHIMII, Vol 40, 1967, p 565], the authors showed that anodic phase oxides produced in sulfuric acid solutions change their physicochemical and anticorrosion properties with a change in conditions of formation. In the present paper an electron microscope was used to study the structure of oxides as a function of conditions of formation. The surface and base of the anodic oxide were photographed with a magnification of 37,000 on the EM-3 electron microscope. The number of micelle structural components per unit of surface and their sizes were determined from analysis of the bases of the anodic oxides. The degree of dispersion of the anodic oxide were formed to depend on the forming voltage. Peptization of particles on the surface of the anodic oxide was enhanced by increased temperatures and current densities. Figures 2; references 5: 4 Russian, 1 Western.
[5-6610]

UDC 620.171.32

EFFECT OF TEMPERATURE ON THE PHYSICAL AND MECHANICAL PROPERTIES OF CARBONPLASTICS

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 80 pp 50-53 manuscript received 3 May 79

ESKIN, E.A. and FEDCHUK, V.K., Institute of Strength Problems, UkSSR Academy of Sciences

[Abstract] The results are presented of experiments on the effect of temperature on the short-time static strength and the elastic and plastic characteristics of carboplastic and carbometalloplastic made of FN resin under tension, compression and bend. It is shown that the change of mechanical properties of these materials is more intense under compression and bend than under tension. Strengthening of these materials under compression in the 200-400°C range was observed. An equation is proposed for approximating the deformation diagrams of orthotropic materials the applicability of which can be determined from the experimental data. Figures 5; references 6: all Russian.
[2-6368]

UDC 669.017.539,4.015

ANALYSIS OF STRAIN HARDENING OF TITANIUM NICKELIDE

Kiev PROBLEMY PROCHNOSTI in Russian No 9, 1980 pp 87-91 manuscript received 12 Oct 79

KAMENTSEVA, Z.P. KUZ'MIN, S.L. and LIKHACHEV, V.A., Leningrad

[Abstract] A study was made of the mechanical stability of strain hardening occurring in TiNi compound of equiatomic composition due to deformation at room temperature. The metal was hot-extruded and then annealed before testing in a vacuum at 800°C for 1 hour. Specimens 4.0 mm in diameter and 30 mm long were deformed at 20°C

by extension on a standard machine at $10^{-2}s^{-1}$ or by torsion at $10^{-4}s^{-1}$. For comparison, 99.9 percent copper, annealed at 500°C for 3 hours, was used. The TiNi alloy demonstrates the shape memory effect after considerable deformation and comparatively high superelasticity. Figures 6; references 15: 8 Russian, 7 Western. [4-7872]

UDC 669.721.5:539

MECHANICAL PROPERTIES OF IMV-2 ALLOY AFTER SUPERPLASTIC DEFORMATION

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 4, Aug-Sep 80 pp 78-82 manuscript received 7 Jan 78

KAYBYSHEV, O.A., SALIKHOV, R.R. and ZARIPOV, N.G., Ufa Aviation Institute, Department of General Technology and Physical Metallurgy

[Abstract] IMV-2 industrial Mg-Li alloy containing (in percent) 8.0 Li, 5.16 Al, 4.7 Cd, 1.38 Zn and 0.21 Mn was used to study the effect of various forms of treatment, including superplastic deformation, on the mechanical properties of this alloy. The treatments consisted of hot-rolled alloy rod, batch mode (heated to 280°C, deformed, and air cooled) and high-temperature mechanical treatment (HTMO) where samples were heated to 330-350°C, interim cooled to 280°C, deformed, water quenched and aged. Deformation of blanks under conditions of superplasticity was done on an MN-100A modernized hydraulic press. After mechanical testing, the tensile and yield strengths increased in the same order as their treatment was listed above while elongation decreased in the same order. The values of tensile and yield strength and elongation were 231, 242, 280, 286 MPa, 167, 179, 218, 220 MPa and 18.2, 14.5, 14.1 and 10.4 percent, respectively. It was also found that after soaking this alloy for 1 week to 2 years it retained its strength whereas the samples treated by the other methods did not have the same property stability. From x-ray analysis of the microstructures it was found that there was an increased Al and Zn content in the Li-base beta-solid solution of the superductile alloy which was double that contained in the samples given the second and third treatments. The superductile alloy also has a more homogeneous structure with the net result being that IMV-2 alloy in the superplastic state has much higher and more stable mechanical properties. Kh.S. GARIFULLIN participated in this work.
References 6: all Russian
[188-6368]

CSO: 1842

END

END OF FICHE

DATE FILMED

3/4/81